IMPRESSIONS

OF A

COMPANY COMMANDER.

BY

LE CAPITAINE BREVETÉ DU GENIE POTEZ,

FROM

REVUE DU GENIE MILITAIRE, JULY AND AUGUST, 1901.

TRANSLATED BY

CAPT. J. R. WILLIAMS, ARTILLERY CORPS, U. S. A.,
CAPT. F. R. SHUNK, CORPS OF ENGINEERS, U. S. A.,
1ST LIEUT. E. M. RIETT, CORPS OF ENGINEERS, U. S. A.

PRESS OF THE ENGINEER SCHOOL OF APPLICATION,
WASHINGTON BARRACKS, WASHINGTON, D. C.
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YAMAHA
SOUND

Impressions of a Company Commander.

By Brevet Captain Potez, Corps of Engineers, French Army.

The object of the present essay is not a general study comprising all the details of command, instruction and administration in an engineer company. To our young comrades, who are called upon to exercise the important functions of captain-commandant, we desire merely to convey a certain number of observations that our personal experience has suggested, and that will perhaps be of some use to them in the exercise of their command.

We have been obliged, besides, to enter into a few considerations of a rather general character. At the present time, in fact, the regiments of engineers are passing through a veritable period of transition. Instruction in the "Schools" has been a thing of the past for several years, nevertheless instruction by company is not customary throughout. The result is that our company commanders do not always enjoy all the initiative that they should have, and that a portion of our methods of instruction, although conforming to the regulations, may still be truly regarded as experimental. Thus we have been induced to discuss the conditions under which the command of an engineer company should be exercised, as well as such modifications in the present instructional methods as it appears to us should be rationally introduced.

We have deliberately left out everything that relates to the general organization of the arm; taking the troops just as they are, we have striven merely to discover the best methods to be employed with a view to their preparation for war.

INTRODUCTION.

THE company, squadron or battery constitutes a unit of command the effective of which is sufficiently limited to enable its chief to know all his subordinates intimately, and which at the same time is sufficiently numerous to require that its command should be intrusted to an officer whose grade and experience will allow full scope to regulate all the details of the command, instruction and administration of his troop-unit.

From all this may be readily explained the vast importance that is attached on all sides, commencing with the regulations, to the office of company, squadron or battery commander.

This applies evidently to the engineers as well as to the other arms of the service.

What is, or rather what should be, a company commander, in a regiment of engineers?

Let us observe that on mobilization, and even now during the autumn manœuvres, the captains commanding engineer companies become, for the most part, in fact, and on a small scale, real chiefs of separate units. If those commanding the companies attached to army corps are subordinate to the chief of engineers of the army corps, those commanding the divisional companies (and these are the most numerous), are directly under the orders of the division commander. On the other hand, if the effectives under their orders are inconsiderable, still, the salvation of the division to which they are attached, or the success of the operations that are under way, may depend on the manner in which they execute the mission intrusted to them, at a given time:—this will be the case, for example, when the company is charged with the task of rapidly preparing for the passage of a stream that the division must cross, either to march upon the enemy, or to escape his grasp, or else, in a retreat, when it is a question of destroying some structure necessary for the enemy's pursuit. On the battle-field, orders will not always arrive opportunely, and officers of engineers will often be obliged to utilize, on their own responsibility, the resources at their disposal in the way of personnel and material, in order to provide for the passage of a stream, to create improvised points of defense, etc.

These officers should therefore, in addition to a thoroughly developed professional education, possess an always vigilant spirit of initiative, and a decisiveness which will permit them to act without hesitation when circumstances require.

These qualities appear even more necessary, if possible, in the engineers than in the other arms (with the exception of the cavalry), where above the captain stands the whole hierarchy, the members of which are at hand to rectify mistakes committed or to direct at short range those subordinates whose methods appear insufficient.

It appears, therefore, that it is in the engineer regiments that the company commanders should enjoy the greatest latitude in the command and instruction of their units. Independently, in fact, of the certain benefit that results from it, from the standpoint of the men's discipline and instruction, it is unquestionably the best means of developing, in the officers themselves, the spirit of initiative, decisiveness and professional instruction.

Now, if we examine what really takes place, we observe that, contrary to what might be inferred from the antecedent considerations, the execution of new ideas, so far as command and instruction are concerned, appears to be more difficult in the engineers than elsewhere.

As regards instruction, this may result partially from the fact that, although the "School" has no longer the instruction of the troops in

its attributions, there remains, nevertheless, in the regiments, from tradition, no doubt, a tendency to centralize, in a manner sometimes excessive, everything relating to this instruction.

In the eyes of certain officers such a method is justified, both for matters of command and instruction, by the two following considerations:

(1) As the technical instruction necessitates the employment of a material which is common to the whole regiment, it is necessary to place the various portions of this material at the disposition of each of the companies in succession, and on this account to impose upon each of them the employment of a stipulated time.

(2) The majority of officers of engineers pass the greater part of their career in the special staff of the arm: when they return to the regiment they must post themselves concerning methods of instruction, of which many may be new to them, and they must also re-acquire soldierly habits,—a faculty which they may have somewhat lost. Some inexperience is to be feared on their part, and it appears indispensable to guide them with a tight rein, both in the exercise of command and in the instruction of their men.

Doubtless the distribution of the instructional material among the companies compels to a certain extent a restriction of the captains as to the employment of time, but it does not seem necessary to go in this direction as far as is generally done, by dividing the area of the polygon into as many "trenches" as there are different schools, all of the companies devoting the same number of drills to the same kind of work. And however, how many causes there are to interfere with all the units having without inconvenience an identical employment of time!

One of the most frequent of these arises from periods of bad weather, which, occurring during the whole or part of the time allowed for a "School," make a certain number of supplementary drills indispensible, and these it is impossible to get with the system before mentioned.

But there is a further consideration. Within the company itself there may be found a case where it is not rational for all the men to devote themselves to the same work during the same drill. Take, for example, a company which has received in its contingent of recruits a certain number of quarrymen, excavators, or miners, being on account of their trade perfectly familiar with various kinds of earth work. Now, as we shall demonstrate below, the training of the sapper in these kinds of work must be considered as an essential part of his instruction. From this standpoint, therefore, it is logical to divide the company into two parts: the first will include the men who, before their incorporation were excavators or of a similar calling, and to whom it will be sufficient to teach the posting of the workmen, the distribution of the tools, the trace and profile of the various trenches of the regulations, and to have them throw up once or twice each style of intrenchment: in the second part will be incorporated those men that, having never touched a shovel or pick before their arrival in the regiment, must be subjected to a methodical training, with

which will cooperate, no doubt, the common exercises of the whole company in battle fortification, but which will be carried into effect especially by a certain number of exercises in excavation properly graduated, and having as their essential object, the hardening of the less vigorous men by the act of throwing up the soil itself. Those who are excavators by trade, and who would derive no benefit whatever from these exercises, will employ their time more usefully in making themselves familiar with the other part of the instruction; in case of necessity even, they may be employed in the details of guard and fatigue, furnished on those particular days by the company, in order to permit those that are most greatly in need of it to be present at these exercises of excavation.

To each captain, therefore, who is better acquainted than anyone else with the progress of the instruction of his company and with the special aptitudes of his subordinates, and who should be without any obligation other than that of completing the different parts of the instruction at the times fixed by the commanding officer, may be advantageously left the task of preparing the employment of the time, which should be submitted, of course, to his battalion commander. To each battalion would be allotted, from such a date to such a date, each class of material; in their turn, the battalion commanders would place the various portions of it at the disposition of their captains, during a stipulated time. The number of drills that the company commander can thus devote to each "school" would have nothing obligatory; it would represent simply a maximum that these officers would not be bound to attain, if less time would suffice to complete the instruction of their men. In such cases, they would have the progress made brought to the notice of the battalion commander; this superior officer might then authorize them to employ the drills not utilized either in certain portions of the instruction which had remained in suspense during the previous schools, provided the necessary material were disposable, or else in outside exercises, of which the number will never be too numerous, etc.

Let us examine now the argument drawn from the inexperience of officers, and see what conclusions should be derived from it.

It is certain that a captain returning to the regiment after eight or ten years' service in the special staff will find many changes in the drill regulations, and in technical instruction and administration; hence the necessity for him of a sort of reapprenticeship, which may betray itself, at the start, by some hesitation in the execution of some parts of the service.

This "brushing up" is indispensible; it must be facilitated by every means, both to diminish the time it takes, and to make it as complete as possible. For this purpose the most efficacious course to follow is certainly to leave to the officer all the initiative that is compatible with his functions. If, moreover, he falls into any error, his chiefs are at hand to correct it before it has had any grave consequences.

On the contrary, to guide the officer with too tight a rein, by substituting one's self, in a certain degree, for him in the exercise of his command,

can only go counter to the end to be attained. Such a course can be no better than a palliative, or rather a dangerous stage effect, good at the best to give regiments capable of making a correct appearance at the general inspection, but—and this is the truly important point—how will these companies be commanded when a mobilization has broken their correct alignment in the barrack square and has removed them from the orderly room and the offices of the school to disperse them in the fortified places and in the great units of command, army corps and divisions? What cohesion will these units present if their instruction has been carried out, not to the complete exclusion of the captains, perhaps, but at least without their cooperation in a really active and personal way?

Should we suppose that, after they have devoted their time to a serious study of the regulations, and after they have received from their commanding officers precise but broad instructions, indicating to them the object to be attained, the time to be employed for that purpose, and, if necessary, in their main outlines, the methods to be followed—should we suppose that out of the men that the annual contingent places in their hands, the majority of engineer officers are unequal to making excellent sappers, capable of doing credit to their companies and regiments? No, certainly not, and if, from the standpoint of military routine, we may have observed a few sins of omission in some of them, excellent officers in other respects this results, partially, no doubt, from the multiplicity of their functions in time of peace, but frequently, also from the fact that during the time they are passing through the regiments their opportunities of acting on their own responsibility have been too few by far.

We repeat therefore that, in order to develop in our engineer captains-commandant both professional merit and the habit of decision so necessary in the field, the only method allowable, we are convinced, consists in leaving in their hands in time of peace the greatest initiative possible in the command and instruction of their companies.

More than once, during this study, we shall be conducted back to the fact that, in time of war, the majority of them will, from a technical standpoint, at least, be almost completely left to themselves,—whence the necessity of accustoming these officers, during peace, to act with a relative independence.

In our opinion this is the controlling idea which should preside in their preparation for war.

Besides it is very clear that to pursue a uniform course with regard to all officers is wholly out of the question, and if, along with company commanders who are vigorous, intelligent and full of animation, there may be found some rather below the mark from any point of view whatsoever, it will be the duty of their immediate superiors, that is of their battalion commanders, to interpose to guard against the disadvantages resulting from any failings observed in their subordinates, and, if it be possible, to eliminate the failings themselves, or at least to diminish them. Thus they will guide with a tighter rein those who betray too much inexperience.

They will stimulate those who sin through laxity, etc. In these very things, in our opinion, should be summed up the essential functions of the battalion commanders of engineer regiments, the battalions of which do not exist as war units, summoned as they are, on mobilization, to distribute their companies among the fortified places, the army corps and divisions.

COMMAND.

(1) *Discipline.*—"Discipline is a virtue which impels us to carry into effect the intentions of the chief, through a sense of duty and in the general interest, by developing to this end the whole physical, moral and intellectual energy of which we are capable." *

Discipline, as it should be understood in modern armies, seems to us to be indicated, in a very precise fashion, in this definition.

What are the means that will enable us to obtain it, and firstly, what sort of a *role* and how much importance should be assigned to punishments?

Always more or less humiliating for those who undergo them, measures of severity can neither inspire nor develop that active sentiment to the immediate chief, wherein discipline consists, as it has just been defined. Punishments may prevent the commission of offenses, but are powerless to implant the desire to do well,—which is however the essential aim of our efforts.

Punishments, in our opinion, are included for the greater part in two distinct classes, corresponding to entirely different necessities: firstly, there are light punishments,—fatigues, or one or two days' confinement, which constitute a means of "breaking in," enabling us to stimulate indolent natures inclined through laxity to neglect certain parts of their duty: in the second class, up to and including transfer to the disciplinary companies and trial by court-martial, are included the more rigorous measures that are necessary in the case of those refractory individuals that have failed to respond to all appeals to their good sentiments, and whose grave and repeated offenses must be the object of stern repression.

Beyond these limits, punishments may and ought to be reduced to a trifling quantity, for it is very often expedient to show indulgence to men who, ordinarily perfectly amenable to discipline, have yielded to some short-lived weakness.

Herein lies precisely one of the greatest means of action of the company commander, and among ideas of this kind, nothing is more detrimental than the *schedules* of punishments which certain commanding officers feel called upon to impose.

In such matters the tact and experience of each are the best guides. We think it our duty, however, to formulate the few following remarks, which may be useful to young officers.

* "Infantry," by General Bounal.

When one allows any offense whatsoever to pass unpunished, it is nevertheless essential to take notice of it by an observation (which will often be a simple sign), for lack of which the delinquent might think himself permitted to do the same thing again, or else he would conclude that his chief had not noticed it, facts which, in the long run, would be damaging to the officer's authority. This observation would be made, should the case occur, in terms to make the man understand without fail that, if he is not punished, it is on account of his habitual good conduct, and because it is considered to be a case of an offense that will never be repeated. Such a method applied with tact will often contribute more than a punishment to the better discipline of the soldier, by attaching him more firmly to his chief.

The only way to obtain a faithful performance of duty is to make the men thoroughly understand what is required of them and to exercise close supervision over all details during their first days of service. This principle, so evidently necessary that it may appear useless to formulate it, is nevertheless very frequently neglected. Directions are given incompletely, without the superior's making sure that they have been fully understood, or even are not given at all, and the man is punished because they are unexecuted or executed badly. Or else again, after orders are properly given and well understood, supervision not being exercised, men relax little by little, and at last become utterly neglectful. Punishments rain down upon the delinquents, but it is too late; the evil bent is formed, and the greatest culprits are the chiefs, who have taken no notice of the first slips, something that might have been done by simple observations. This explains why the best governed organizations are generally those in which punishments are reduced to the minimum.

These last considerations are of supreme importance in the training of recruits during the period immediately subsequent to their incorporation. We shall have occasion later to recur to this matter, in speaking of the arrival of young recruits in the company.

It is therefore unquestionable that punishments, considered as a necessary evil, play only a secondary part in the establishment and maintainance of discipline as it should be understood. The essential elements which combine to realize this aim correspond to three different classes of ideas.

(*a*) *The merit of both chiefs and soldiers*, the consciousness of which gives the man confidence in his superiors, in his comrades and in himself.

(*b*) *Moral education*, aiming to develop in the soldier patriotism, devotion to the flag, and the sense of duty.

(*c*) *The solicitude of the chief for the material and moral welfare of his men.*

Let us examine these in succession.

(*a*) *The merit of both chiefs and soldiers.*—The soldier, to be truly the instrument of his chief, must be conscious of a real superiority in the

latter, making him worthy in all respects of the authority with which he is invested.

An inefficient chief may by the menace of punishments command the obedience of his men, but he will never have their confidence. Young officers ought to be thoroughly convinced that, by developing their professional merit, not only will they qualify themselves the better for the proper exercise of the functions of their grade, but they will see singularly increased their sphere of action over their subordinates.

But it is not only the instruction of the officers that is important from this standpoint; the instruction of the men, down to the lowest degrees of the scale, when it is well executed, induces reciprocal confidence among all the elements of the unit; it is the same way with the moral worth of each soldier, taken individually. From this confidence of all with regard to all there results a firm cohesion, which forms the most invaluable of qualities for a company in the field.

From this also springs *esprit de corps*, which is excellent in itself, provided that it be not exaggerated, and that the consciousness of the merits of one's own arm be not combined with a sort of scorn for everything external. The consequence might be, as is unfortunately sometimes the case, that soldiers who are entirely devoted to their immediate chiefs show themselves much less disciplined as soon as they are placed, either alone or in small parties, under the orders of officers of other arms.

The comradeship of arms, which within a few years has made such great progress in our corps of officers, should extend to the men to receive its full development. Even more, perhaps, than for the soldier of other arms, this quality is necessary for sappers, summoned as they often are, in small detachments, to lend their aid to troops of other arms. Moral education, tending to develop in the man the most lofty sentiments, permits us to impress upon the soldier the necessity for mutual devotion in all the elements of the army; and from this point of view its most useful complement will be found in grand and garrison manœuvres, and in general, in all opportunities, which should be made as numerous as possible, for combined operations of troops of engineers and detachments of other arms.

(*b*) *Moral education.*—The daily routine of duty already furnishes to the captain the means of acting, to a certain extent, upon the moral being of his subordinates. But his educational functions should not be confined within these limits.

It is not enough, in fact, to limber and strengthen the body of the soldier; to teach him to handle the arms and tools he will use in war: to obtain precision in the execution of the daily routine in time of peace: it is also and especially necessary, as far as the nature of each individual will admit, to develop in him moral qualities of the very highest order, —that is, absolute devotion to the fatherland and to the flag, and the spirit of abnegation which impels the soldier to sacrifice his life without hesitation, when the interests of his country require.

For this purpose the captain will assemble the whole company from

time to time, and will endeavor to impress upon his men the nature and importance of their duty to the country. Some officers hesitate to do this, believing that they are not gifted with sufficient fluency of speech; let such men lay aside all apprehension. To devote one's self to philosophical dissertations, which would be incomprehensible for the majority of the men, is not the question. In the midst of Europe in arms, the more than ever imperative necessity for the entire devotion of every Frenchman to his country should be briefly discussed, and a few elements of the history of France, and especially of the history of our own times, should be given to the soldier,—facts which will indicate our probable enemies, which will remind him how Germany prepared and conducted the War of 1870, and which will impress upon him the obligation for all Frenchmen, if they are unwilling to fall into decadence, to reestablish some day the integrity of the territory of the fatherland.

No abstractions in these familiar conversations; the anniversary of a battle taken part in by the company, an act of devotion performed by some soldier of the regiment, in a general way, every incident supplying a theme for an excursion susceptible of touching the heart and imagination of the soldier, will give the captain opportunity for a discussion very summary, if need be, in which the lesson or example to be drawn from it by each man will be made plain.

No necessity to be an orator for that. In such matters the officer has only to allow his heart to speak: this will be his surest way of touching the hearts of his men.

Let those comrades of ours try it who have hitherto not thought it their duty to employ this method of education. To be convinced of its efficacy, it will be enough to see the faces of the men listening to the captain, when he is explaining one of those questions, capable of solution for a great nation like France, by life or by death, or at least by incontestable greatness, or irreparable decadence.

(*c*) *The material and moral welfare of the soldier.*—The regulations prescribe that all officers, of all grades whatsoever, take the most solicitous concern in everything connected with the material needs of the soldier. In the absence of any other reason, these instructions would be justified by the evident fact that the physical effort that may be demanded of the man, his resistance to all kinds of fatigue, bear a direct ratio to the manner in which the body is maintained in a good state of vigor and health.

But this material result is not the only one to be obtained by a chief truly anxious for the welfare of his subordinates. It is clear, indeed, that since the physical reacts upon the moral being, the latter will be so, much the better for the soldier's being more vigorous and better trained; but there is another consequence equally deserving of our attention. The feeling that his chief is concerned in his welfare exerts an excellent influence on the man's state of mind; on the contrary, nothing is more depressing for a company than to perceive that its commanding officer lacks interest in its material needs.

The moral welfare of the soldier demands equally our care. To make the recruit, unacclimated in the new element in which he has to live, feel on all sides the sympathy of his chiefs and of his comrades; to take care that the non-commissioned officers show moderation as well as firmness in the exercise of their authority; to repress extravagance of language and harsh words, which merely irritate the victims against their superiors; and in general, to spare the soldier every useless shock,—all these means contribute to the foundation of good discipline, ensuring the chiefs, not only the respect and obedience, but also the sympathy of their subordinates. A mark of solicitude, which is a cheap attention for the officer who gives it, often ensures him the deep attachment of the soldier concerned, during his whole service and even in years to come. It may be a favor to a man on the way to a sick parent, a visit to the hospital or to the infirmary, or even less, some trifle perhaps, but to the soldier it is proof enough that his chief takes an interest in him.

(2) *Officers.*—A very interesting and sometimes a very delicate part of the functions of the company commander consists in his sphere of action over his subaltern officers.

A young officer graduates from Fontainebleau or Versailles; he joins the regiment with a good theoretical education, but he lacks the practical part of his profession, and in order to become a good company officer with all the authority due to sterling professional merit and a profound knowledge of men, he will find many things to be done. The importance therefore of the first impressions received and the great influence of the first immediate chief, the first company commander, may be readily conceived. The greatest concern for his lieutenants, and particularly for the recent graduates, the first steps of whose official career he should guide with all possible solicitude and tact, should therefore be an essential duty for the captain.

Doubtless the captain is not and should not be the only one to direct and instruct the lieutenants under him; the field officers and the colonel especially participate to a great and even a preponderating extent. We often hear "Like colonel, like regiment," which amounts to saying, from the standpoint which concerns us, "Like colonel, like corps of officers." Now the young lieutenant or second lieutenant is readily affected by the new environment in which he is called to live.

But although thus limited, the captain's task is fair enough to monopolize his care.

We have striven to prove that the greatest initiative possible should be left to the company commander; the same principle will guide this officer in his dealings with his subordinates and especialy with his lieutenants.

Of course the degree of initiative left to the latter should be carefully proportioned to their degree of experience: however, unless incompetency is visible in an officer, a company commander should be guided by the two following rules:

(*a*) To reduce orders and instructions to what is strictly necessary,

and for this reason, never to settle a detail that can be settled by a lieutenant.

(*b*) Orders once being given, to interpose in the execution thereof only if he foresees that the subordinate will encounter a check; if the result of the first measures taken is merely a waste of time or some similar inconvenience, he should allow him to continue the course he has adopted When the work or exercise is finished, he will explain to the officer that such another method would have effected a saving of time, of personnel or material. The lesson will be thus much more profitable.

This rule does not apply, of course, when the company has to take part in combined manœuvres.

When the captain comes to a decision of some importance to the discipline, instruction, or administration of the company, it will generally be profitable to acquaint his lieutenants with the reasons which have determined him. By taking this course, not only will he qualify them for their functions when they are themselves company commanders, but he will post them thoroughly as to his views on various matters of duty: in this way he obtains the priceless result that, if he is absent or not available, these officers will act, if not exactly as he himself would have done, at least in a manner generally conformable to his intentions.

The performance of duty is the more precise and enthusiastic as it is made the easier and the more agreeable: on the other hand, a captain who endeavors to spare his lieutenants useless drudgery may on this account be more exacting in the various duties where what is accomplished by the officer is of some real use.

Must we add that a captain really worthy of the functions devolving upon him will find it not unprofitable to treat his subalterns as comrades? The captains who keep their lieutenants at a distance are often officers, who, conscious of their inferiority, fear to compromise their authority by allowing their subordinates to become too well acquainted with them.

Such captains are only to be pitied; but to those who, for any other reason, think it their duty to act in the same way, we fearlessly affirm that they can not fail to gain by a change of method. Their subordinates, taken more into confidence, will acquire more assurance in the routine of duty; the ideas and intentions of the chief being well known to all, duties will be performed more readily, without any of the jarring which occurs too frequently in the units where cohesion is lacking, because the chiefs have been unable to establish the necessary unconstraint in their relations with their subordinates.

It is hardly necessary to say that the captain's good example, that is, the most scrupulous precision on his part in the performance of every duty, is the best means yet at his disposition to impress the sense of duty vividly upon his young subalterns.

As to the instruction proper of his lieutenants, it should consist almost entirely of practical exercises, and the daily routine is from this stand-

point the best of schools. There is however a portion of this instruction to which we think we should draw attention, for it is generally, in our opinion, not sufficiently developed: we mean knowledge of other arms and of general tactics.

Everybody agrees in acknowledging that whether an officer belongs to the infantry, cavalry, artillery or engineers, he is but half formed, if he is insufficiently acquainted with the other arms; this condition is necessitated by the reciprocal aid that the various elements of the army should lend each other on the battle-field.

Now it must be observed that, except in the exceptional cases where they are utilized as infantry, the mission of engineer troops in battle always consists in preparing or facilitating the action of one or several of the other arms: on the other hand, during an action, as we shall see later in speaking of technical instruction, engineer officers should be at all times qualified to grasp the situation, in order to seize without hesitation the opportunities where they are privileged to employ, on their own initiative, the personnel under their orders. We may conclude from these two considerations, especially if we bear in mind that no intermediary exists between the divisional commander and the divisional captain-commandant, that, among officers of all arms, the engineers stand most in need, perhaps, of thorough tactical instruction, both as regards tactics in general, and the tactics special to each arm and particularly to the infantry and artillery.

Besides, if we may judge from what happens ordinarily during grand manœuvers, the captain of the divisional company will march in the field, as a rule, with the division commander; the company will thus find itself under the command of a lieutenant perhaps extremely young in rank. Doubtless here will be no great inconvenience in this as long as the company has nothing to do but to march in its place in column, but suppose that an action becomes imminent, and that the captain, sent on a reconnaissance or prevented for any other reason, does not immediately rejoin his company, the lieutenant will succeed to the task of guiding it in the midst of troops of all arms, and of formulating the important decisions, the necessity of which may be evident from time to time.

One can not therefore begin too soon to develop practically, as far as possible, the tactical instruction of young engineer officers. Reconnaissances, double action exercises on the map, manœuvres of all sorts, will, from this standpoint, be of the greatest profit to them.

THE NON-COMMISSIONED OFFICERS.

The part played by the sergeants of a company is of capital importance. They are the indispensable auxiliaries of the officers in all the details of military duty, and its proper execution is thus dependent, in great part, on their efficiency.

In permanent contact with the men, they exercise an immediate influence on them; their *esprit de corps*, and their manner of performing their duty has consequently, a considerable effect on the company as a whole, and the greatest care of the captain should be, to have a good body of non-commissioned officers. The adoption of the the three-years' service rule, by bringing about a much more frequent renewal of this grade, has rendered the task of the company commander so much the more difficult. Formerly, when the five-years service rule was in force, each year at the liberation of a class, about one-third of the non-coms were lost those who remained maintained the traditions, and the newly promoted men formed themselves, so to speak, on their older comrades. Now it is no longer the same; each year, in September, the companies have their body of sergeants entirely renewed, with the exception of the first sergeant and one, or rarely, two reenlisted sergeants, also possibly a sergeant who was not discharged, having been promoted to this grade before two years service, or from those men who are enlisted for four years; but the sergeants coming under these last two heads are not numerous in engineer regiments. The new sergeants are imbued with a spirit and bring into the company habits which are not those of the new surroundings in which they are called upon to serve. The result of this arrangement is a somewhat critical period which should demand all the attention of the captain.

A first means of lessening this inconvenience, is to require that a man who has served in the company as a corporal be assigned to it as a sergeant.

By taking care in the selection, one will thus have, together with the reenlisted men who generally remain, a nucleus which will greatly facilitate the breaking in of the newly promoted men coming from other companies.

It is also very useful in this connection,—but this is the colonel's business—that the vacancies amongst the sergeants which are produced at the liberation of the class, be not filled all at one time; but, for example, by means of two separate promotions, one at the end of September, the other a few days before the arrival of the recruits.

Upon receiving his new sergeants, the captain should explain very clearly the way in which he understands that their duties should be performed. It would be an error to believe that the regulations indicate in detail the duties inherent to each grade, so clearly as to dispense with this. The inexperience of the young sergeants needs a guide: also, it is clear that, in a company, all those who exercise any authority whatever, should do so in conformity with the views of the captain and it would be improper, viewing it in this way, to abandon the new sergeants to their own devices.

It is especially necessary to make them understand properly, from the time of their arrival in the company, that the actual execution of the

details of the military duty rest almost exclusively on them; to inspire in them the greatest horror of lying, unworthy of a soldier whatever his grade, and which ought to be combatted by every possible means; in return, to show them such confidence as will raise them in their own estimation. They will thus acquire, of themselves, the habit of doing their duty conscientiously even in the absence of their officers and when any verification on their part is impossible. A few marks of interest, properly shown, will succeed in making of the new sergeants subordinates who are entirely devoted to their captain; let there be added to this a discrete supervision of the details of their duties at first and the firm yet kindly correction of little well appreciated faults, and you will have, at the end of two or three months, sergeants who, with few exceptions, will be valuable auxiliaries to their chiefs, entirely competent in the performance of the duties which have devolved upon them.

Of course officers will never intrude upon the rights and just authority of their sergeants and the attention of the lieutenants should be specially called to this point. On the contrary, in proportion as they acquire experience, they will be left more and more to themselves and will be intrusted with tasks as little beyond those which properly belong to their grade; the double advantage will thus be obtained of giving them greater prestige in the eyes of the company and preparing them to replace their officers in case of necessity.

It must be recognized that many captains who complain of the inefficiency of their sergeants have only to examine their own consciences; they will appreciate that if they had not left them so much to themselves at first, and had not waited before intervening until the effect of the bad habits acquired had made itself felt, and if, on the contrary, they had seized all occasion to develop self-reliance and initiative in them, such mediocre sergeants would have made very fit non-commissioned officers. Certainly the restricted time of service does not facilitate the task of the company commander, but this is the more reason for his devoting every care to it. The way in which the sergeants perform their duties depends upon the manner in which they have been brought up by their captain, and it may truly be said that the quality of the sergeants of a company and the spirit which animates them, are the true touchstones of the worth of the officer who commands them.

THE CORPORALS.

Although modest in rank, the grade of corporal is none the less one of the most difficult; the man who occupies it usually has not had enough experience to teach it to his subordinates; the life in common with these latter leads almost necessarily to such familiarity that it is not conducive to increasing his authority; it may even be said that a corporal depends, to a certain extent, on the men of his squad, for, being engaged in a very absorbing duty, he is often obliged to appeal to their good-will to prepare his accoutrements, clean his arms, etc.; if, in addition, as sometimes

happens, unfortunately, he has a difficulty with the sergeants who, instead of aiding him in the performance of his duty, shoulder on to him a part of theirs, one appreciates how thankless the grade of corporal may be. In certain cases his duties are very numerous; he depends on a number of superiors and in spite of all his good-will, he does not succeed in satisfying all.

The captain therefore has numorous reasons for being very solicitous concerning his corporals. He ought to aid their inexperience by his advice, supervise as closely as possible the discipline in the interest of the squads and facilitate them in the performance of their duty as far as lies in his power. Almost all of them being destined to become sergeants he will attach the greatest importance to their military and technical training.

This question of promotion from the lower grades leads us to say a word concerning the special "platoons of instruction" which are still in use in the engineer regiments

A few days after their incorporation, the recruits are examined in the companies with a view to primary instruction. where they are given a dictation exercise and two or three problems; those who come out the best are proposed to join the "platoon of special instruction." We may remark that this assignment is made solely in accordance with the results of the primary examination as the men have been in the service too short a time for their captain to be able to appreciate them from any other standpoint.

From this moment they escape from their company commander almost completely; if, in certain cases, their theoretical instruction may gain by it, their military education and their practical instruction certainly suffers.

Those who are not extraordinarily awkward at drill, or of notoriously bad conduct or who have not a particularly poor memory reach the time of the disbanding of the instructive platoon without mishap; each of them is then given a classification number which depends principally on the greater or less facility with which the lance corporal has learned the "letter of the theory." With rare exceptions, promotion of the "candidates" to the grade of corporal is made in the order of their arrangement in the platoon of instruction.

We may therefore sum up as follows: Designation of the lance corporals in accordance with the result of the primary examination, classification in the instructional platoon, then promotion to the grade of corporal in accordance with the more or less fortunate memory which each man shows.

We need not reiterate the artificiality of such a process.

What precedes applies to the instructional platoon of the lance corporals; the same difficulties are found in that of the lance sergeants with this extenuation however, that the non-coms who form part of it, having had some service, it is possible to know more of their military qualities. Nevertheless, here again memory plays the principal part. We conclude from this that instruction in the company ought to be applied to the

lance corporals and sergeants as well as to the men. Besides, we do not see why, what is recognized by the most competent military authorities as good for the infantry, should not be so for the engineers; it being admitted on the other hand that we have never seen instructive platoons organized except for military instruction, properly so called; all that which relates to technical works being taught in the same company to all the men whether they are or are not to receive advancement.

The consequence of the instruction of the lance corporals and sergeants in the company is almost necessarily that they are promoted in their own unit. It has been remarked that the result of this might be that some of the non-coms may not have, for some time at least, sufficient authority over their former equals; but this difficulty, when it exists, and it should not be exaggerated, is more than compensated by the following advantages. In the first place, the captain, knowing that he is preparing his own body of sergeants and corporals, will exercise so much the more care in the instruction of the men who, by their character and manner of serving, appear to him apt to become good non-commisioned officers, having real authority over their men; you will never see—as sometimes happens with the system of changing newly promoted men from one unit to another—a company commander recommending a worthless corporal for a sergeancy with the sole object of getting rid of him; finally, then, will be avoided in great part, the difficulty mentioned above of renewing almost the entire body of inferior non-coms when a class is liberated.*

The newly promoted men, remaining in surroundings which are familiar to them, and well acquainted with the ideas of their captain, will have an infinitely easier apprenticeship than in changing company.

We may say, moreover, that we have requested and obtained several times, in the company which we had the honor of commanding, the promotion in place of lance corporals or sergeants; we have never remarked that they had less authority over the men than their comrades who came from other companies.

It is objected also that one does not find in all the units the necessary resources of the non-commissioned officers to carry on properly the instruction of the lance corporals and sergeants; but it does not seem that this obstacle is insurmountable. The result of it would doubtless be an increase of work, principally for the lieutenants and sergeants, but this is nothing when we regard the advantages which are procured by the instruction carried on in the interior of the company, as compared with that given in platoons of instruction.

THE MEN.

As far as regards discipline, we have set forth almost all we have to say concerning the men. We will have occasion to complete it further on, in

* 1. Let us remark that it is always possible to avoid it by changing from a company in case of need, the non-coms for which this measure appears useful.

2. What we have said in this connection concerning sergeants applies equally to the corporals; if they are not all promoted to sergeancies, at the departure of a class, there remain for the most part in the companies only two or three, usually of only medium efficiency or very young in rank.

speaking of military and technical instruction. We wish here only to draw attention to the circumstances surrounding the incorporation of the recruits.

A few days before the arrival of the recruits, the captain should assemble the non-commissioned officers of the company in order to instruct them concerning the way in which he intends that the recruits should be treated during the first days of their presence under the flag.

The young men whom we receive almost always arrive animated by a desire to do well: many of them feel a certain apprehension which paralyzes the more timid, and which it is necessary to be careful not to take for ill-will. Rigorous methods ought therefore, except in entirely exceptional cases, to be completely set aside; the non-coms and particularly the corporals in command of squads, ought to rival one another in zeal to teach the recruits the various details of their daily duty: at drill, the instructors should avoid all harshness.

It is only after some time, when the recruits are somewhat acclimatized that the faults really imputable to laziness or ill-will can be picked out; then only, after one or two observations have been allowed to pass, it will be proper to make use of a few slight punishments which will usually suffice to bring the man back to the proper path.

One thing which it is necessary to watch very closely is the assignment to fatigue duty. There are often, in the contingent assigned to a company, one or two recruits particularly lacking in intelligence, although, in the beginning, at least, they do not bear ill-will in the performance of their duty, yet they find themselves picked out and taken in hand by the inferior non-commissioned officers. If care is not taken, these men will find supplementary fatigue duty without the knowledge of their officers. No longer having time to clean their own arms and equipments, they are punished for slovenliness, they become excited and end by committing an act of insubordination for which they are severely reprimanded. Their morale is completely demoralized by the bad subjects which they meet in the guard-house: they come out of the guard-house worse than they entered: from this time, they are on the downward path where perhaps nothing will stop them. The captain ought, therefore, to watch closely those men who are pointed out to him during the beginning of their presence with the flag, as being particularly difficult to train. Otherwise, it will do to keep very close control of the fatigue duty, which he will frequently verify.

This shows us that it is very useful, during the first few days after the arrival of the recruits in the company, that their captain should have some idea of each of them in particular.

For this purpose, from the day after their incorporation, he will compare them individually, will question them concerning their occupations in civil life, the condition of their family, etc., and will enter with care all this information in a note-book, to which other information may be added later, as he knows them better. The whole will constitute for

each man papers which the company commander will consult very usefully in many circumstances (leaves of absence because of the applicant being necessary to the support of his family, for harvesting, leaves of long duration, applications of all kinds).

This method of procedure is advantageous from another point of view; the recruit sees in it a first mark of interest given him by his chief, who thus ceases to be a complete stranger to him as soon as he arrives in the company; this fact contributes to stimulating his good-will and suppressing any feelings of apprehension which interfere with his usefulness.

Therefore, to sum up, the duties of the captain should be exercised with great firmness, care and kindness.

Of course, details vary and should vary with the chief who employs them, as well as with the men to whom they are applied, and that which succeeds in one case may not be suitable in another; we need not consider the three conditions above indicated as any the less necessary; the individual temperament of each captain will only give predominance to one of them without ever allowing him to suppress any one of them completely, if he desires to be sure of being able to obtain, everywhere and under all circumstances, the best possible result from the men the country has intrusted to him.

Part II.

INSTRUCTION.

All officers who, during the past few years, have been concerned with the instruction of engineer troops, can testify how difficult, not to say impossible, it sometimes is to give sufficient time to each of the different branches which make up this instruction, military as well as technical.

Such a situation is due to several causes, to remove which is not within the sphere of the company commanders; they can only endeavor, by redoubled zeal and activity, to diminish the resulting ill effects.

However, on account of the extreme importance of this question, and although it is but indirectly related to the chief object of our paper, we have thought best to set forth, on this subject, certain considerations, which for the sake of clearness we have relegated to an appendix at the end of the present essay. We shall then confine ourselves in the following chapter to a few remarks which seem to us likely to be of interest to our young comrades called to command companies.

Since the relative importance which should be attached to such or such part of any given branch is usually in question, we must suppose the captains left free, as much as possible, themselves to regulate the employment of their time, subject to the approval of the battalion commander, and in compliance with the two following conditions:

(1.) To finish the different parts of the course at the times fixed by the chief of engineers.

(2.) To reduce to a minimum the time, after the incorporation of the recruits, during which the company can not be mobilised with all its elements in working order.

MILITARY INSTRUCTION.

DRILL REGULATIONS.

Existing orders provide that the infantry drill regulations shall be applicable to engineer troops. It is quite certain, however, that the latter, by reason of the exigencies of their special instruction, can not study or practice these regulations to the same extent as the arm for which they are more particluarly intended. This, besides, would be use-

less; for engineer troops, when in exceptional cases they are employed as infantry, are so employed under absolutely special conditions, which do not demand in the sapper all the qualities which a good infantryman should possess.

For the details of this instruction, we can not do better than to refer our comrades to the remarkable work of General Bonnal. Of course, we must take into consideration the fact that it is almost impossible for engineer troops to engage in certain exercises, such as boxing and single-stick, which doubtless would be to their profit, but which must yield precedence to other branches of instruction much more important to the engineer arm. However, we must avoid falling into exaggeration, and considering everything in the way of gymnastics to be useless to the sapper. Running and jumping, in particular, might be practiced to a greater extent than is usually the case.

The necessity of recurring frequently to individual instruction and exercises in detail is perhaps greater in the engineers than in any other arm. The goings and comings on the engineer drill ground, where it is impossible to exact absolute and continual correctness from men often burdened with the most various loads, rapidly gives to the sappers, if one does not look out for it, a habit of carelessness most prejudicial to good execution of movements as soon as close formations are resumed. It is then indispensable, over and above the drills properly so called, to take the men in hand whenever the occasion arises.

FIELD DUTIES.

In the instruction in field duties, the dispositions will frequently be studied, which must be taken by a company or a detachment of less strength to protect itself when acting alone. The case of the company employed as a unit of the guard in a complete system of outposts must indeed be regarded as quite abnormal; while a detachment of engineers may often be required to provide for its own security in cantonment or bivouac, when, with a special mission in view, it is employed in front or on the flank of the army, covered at most by a few small bodies of cavalry.

As regards the call to arms, it is essential that the company be well trained to assemble in the minimum time without drum or bugle. A company of engineers is in camp in a locality also occupied by bodies of other arms. In the middle of the night, its commander receives orders to set out immediately with his company to make a demolition, repair a crossing, etc. The company or the detachment must, in this case, be able to assemble rapidly, and to do this in silence, so as to disturb in no way the rest of the other troops. To this end, the quarter-guards will make themselves familiar with the quarters of the officers and the non-commissioned officers, so as to be able to waken them in the night without any groping about. On their part, the sergeants will know exactly the sleeping-places of the chiefs of squads, and the latter, those of their men. In drills of this nature, the non-commissioned officers must be accustomed to

arrive at the place of assembly with their half-sections or squads complete; and must be made to understand that a sergeant or a corporal does not fully perform his duty in reporting to the captain the absence of such or such a man; he must first have done everything in his power to find the man. Whenever the company is required to pass the night out of barracks, these measures will be strictly enforced, so that everyone may become thoroughly accustomed to them.

In the matter of marching, the engineers must be as expert as the infantry; because not only must the companies be able, without great fatigue, to keep up with the bodies of infantry of which they form an integral part, but sometimes they will even be called upon to double the day's march, only to begin work on arriving at their destination.

This training can not be obtained by means of marches performed once a week, or once a fortnight. Such exercises, so spaced, will only enable a previously trained company to keep up the habit of marching. It is necessary for the end in view to cause the company to make, consecutively—excepting necessary days of rest—eight or ten marches of increasing length. Two weeks may be given to this purpose, which will be utilized in the following manner:—

1st Week.	2nd Week.
Monday, 15 km.	Monday, 22 km.
Tuesday, 18 km.	Tuesday, 25 km.
Wednesday, rest.	Wednesday, 25 km.
Thursday, 18 km.	Thursday, rest.
Friday, 20 km.	Friday, 30 km.
Saturday, 22 km.	Saturday, 35 km.
Sunday, rest.	Sunday, rest.

It will be advantageous to make these practice marches at the end of winter, between the termination of recruit instruction and the beginning of the season on the engineer drill-ground. At this time, the young soldiers are under better control of their instructors than at any other, and consequently, no time is more favorable for accustoming the company to march with all the precision compatible with the condition of the road and the state of the weather. This instruction is of the greatest importance, and it may be said that the appearance of a company on the march, when it has just made 30 km. in bad weather or over a cut up road, is one of the best criterions of its instruction, and even of its morale.

Taking this view, some officers advocate the use of the cadenced step; and, in certain army corps, the route step has been forbidden except in crossing fields. This measure is somewhat debated; and in fact if it does give a fine appearance to the company on the march, and permits an almost exact maintenance of lengths and distances, it is certainly a cause of great fatigue to certain men of exceptional conformation, and even for the whole company, if the condition of the road followed is only a little short of perfect.

However this may be, experience shows that after a few consecutive marches men at route step will be found to plant one foot—right or left indifferently—almost all at the same time; this no doubt results from the fact that being habituated to the cadenced step, they have a tendency to plant the foot at the moment when they hear the sound to which their ears are accustomed. This being so, every man, in order to march more easily, is led to take the step of the man in front of him, so that one may say that after three or four consecutive marches the company, allowed to take the route step, will take of itself a gait which differs from the cadenced step only in this, that the step usually changes from one section to another throughout the company, and even in the middle of sections. This is the result of the little breaks which are necessarily caused by the irregularities of the road, however trifling these may be; it is due to this fact that one sees the men frequently change step, when the cadenced step by company is used.

We conclude from what precedes that if the employment of the cadenced step by company, imposing it on all the men, is not without objections, the use of this gait by section presents nothing but advantages, with the understanding that the men who can not conform to it without fatigue shall be left free to take the route step. Under these conditions the cadenced step, far from being an inconvenience to the soldier, facilitates the march, and permits as far as possible the preservation of the alignment by ranks and files, which must be observed whenever the state of the road does not require that the men be allowed to choose at will the best paths, or the temperature does not necessitate increasing the intervals.

If, on his part, the guide takes a regular step, if he is careful not to increase the gait on descents nor to decrease it on ascents, we shall thus reduce to a minimum the lengthening out and the resulting fluctuations which are the chief source of fatigue to the men when the road is good and the temperature normal.

We must remark the propriety of performing these field-duty drills by company and not as is sometimes the case by battalion and even by regiment. Leaving aside the entirely exceptional case in which the three companies of an army corps are united for some specified duty, it is always by company that engineer troops in campaign will operate, and it is essential that the captains become accustomed to acting on their own responsibility, without other instructions than the very general ones which will be received from their immediate superior authorities, and to regulate without hesitation a number of details which, in an infantry regiment, fall to the colonel or the majors.

FIRING.

Without having the same importance as for infantry, firing nevertheless constitutes one of the essential portions of the instruction of engineer troops.

It must first be observed that in the instruction of the marksman,

whether he be an engineer or infantryman, two very distinct objects may be contemplated: 1st. To make the man acquire great skill at target practice,—in other words, to make him a good shot on the range: 2nd. By frequently repeated drills, so to accustom him to the motions of loading and aiming, that they become instinctive in the soldier, and are correctly executed even at short range, in spite of the emotion caused by the proximity of the enemy. It is certain, indeed, that in proportion as the distance between the hostile forces diminishes, the number of men who are really in condition to take careful aim becomes less and less; at the moment of the decisive fire, all that can be asked of them is to shoot into the crowd.

Is one justified, therefore, in saying that skill in target practice is useless? Certainly not. The infantry especially in order to embarrass the service of the hostile batteries, may have need of carefully aimed fire, delivered from such a range that the emotion experienced by the good shots who will be employed in such a case, will deprive them of only a small portion of their habitual powers: again, on the defensive, when fire is opened at a great distance, many men will be able to utilize the skill which they have acquired on the range, etc. But there is another reason which by itself would justify the importance usually attached to target practice; when a man shoots well, he acquires a confidence in his weapon which has the best effect on his morale.

With special reference to engineer troops, it is to be observed that when they do fire, it is when they are immediately threatened by the foe or when they are employed by the commanding general, in default of infantry, to oppose a too pressing enemy. This indicates that shooting at long range—by which we understand a distance greater than 800 to 1000 metres—will be the exception for engineers; it will almost always be at short distance that they will have to fire.

It is therefore important, for the reasons just indicated, to make them execute very frequently the motions of loading and firing. To this end, every time that the company, for any reason whatever, falls in under arms, it will go through the motions of a few volleys and of firing at will. In any case, these exercises, which take up very little time, should be given not less than three times per week.

As to target practice, the method laid down in the firing regulations, properly applied, allows most of the men to acquire sufficient skill in this kind of drill. However, after a certain amount of instruction firing, a persistent lack of proficiency is noticed in a certain number of men. In some of these, this results from defective vision, which must be corrected by suitable glasses. Some of the others jerk the shoulder or the finger, as pointed out in Art. IV of the firing regulations (Causes of Irregularities in Firing) which sets forth the means of remedying these defects. But the unskillfulness of the greater part may be ascribed to another cause, this is, that the men, before they succeed in directing the line of sight on the object, become fatigued in the arms or in the eyes, so that

they can no longer attain this end, try as they will; despairing of success, they finish by pulling the trigger almost at random; it is obvious what the result of firing under these conditions must be. For these men who, we repeat, form the great majority of the unproficient, there is a very simple and effective remedy, which, moreover, is no other than the method of perfecting themselves used by many good shots: it is to practice them for a few minutes every day in directing the line of sight on any given point and holding it in that position as long as possible. At the end of a few days of this treatment, we shall see satisfactory results obtained by the greater part of the men who previously could not hit the target.

In addition to the instruction of the men, there is that of the officers, which, at least for the infantry, is still more important; it comprises the estimation of distances, the use of the different fires, the regulation and control of the firing. The fact that we have pointed out, that when engineer troops are called upon to fire it will almost always be at short range, certainly very much simplifies this part of the instruction of the officers of the arm; still, we must be careful not to conclude from this that it may be completely omitted.

TECHNICAL INSTRUCTION.

As regards the details of instruction in sapping, mining and bridge-building, we have no remarks to make; we will only say a few words on the fortification of the battle-field and on technical instruction in winter.

FORTIFICATION OF THE BATTLE-FIELD.

Field-works may be divided into two distinct classes: the first includes the more or less deliberate works permitted by a defensive organization of some importance, carried on out of the presence of the enemy: in the second we place those which have to be executed in the presence or under the immediate menace of the enemy, and in a very limited time,—sometimes a few minutes: for example, putting into defensive condition a point of support just occupied by the advance guard, preparing an outlet for a column about to attack, etc.

The execution of works of the first kind may always be accomplished by very ordinary laborers, on condition only that they are relieved often enough. Those of the second class, on the contrary, require a rapidity in laying out and beginning work, and a vigor in the execution, which certainly can be attained only by specially trained troops.

In the first case, therefore, the use of working parties of infantry is clearly indicated, except for works which require special instruction or an outfit which none but engineer troops have; moreover, this will most often be inevitable, for the number of the engineers is too small to allow them to complete by themselves the works of all kinds required by a defensive organization with any pretensions to completeness.

It would appear preferable, when possible, to spare the sappers at this period of the operations; thus avoiding the premature exhaustion of a strength which they will need in order properly to carry on the manifold tasks which will devolve upon them in the course of the battle itself.

At that time—and especially when the action is an offensive one—the infantry will have other things than work to do: they will be on the firing line, assembled in expectation of the order to engage, or on the way to the battle-field. Therefore the work of all kinds whose necessity is successively perceived in the course of the action will fall almost exclusively upon the engineers. While the companies with corps headquarters will be charged with those which are in some sort of general importance to the army corps of which they form a part, such as the preparation of positions for retreat, the destruction of important structures, etc., the divisional companies, closely accompanying the infantry, will have to perform the task of putting in defensive condition the points of support seized by the advance guard, as well as those which the infantry takes possession of in the preliminary combat; to contrive exits and roads in order to facilitate the movements of infantry and artillery, etc.

Above all, it will be in presence of an attack coming from an unexpected quarter that the greatest efforts will be required from the engineer troops. If these are well trained and well commanded, they may in a few minutes organize a point of support which, however precarious, will perhaps permit the small number of men available to gain the necessary time for bringing up reserves. As to the captains, they must usually in such cases act on their own responsibility, with waiting orders which, if they reach their destination at all will almost always arrive too late.

In order that this part may be well played, it is necessary that the engineer officers be as well informed as possible as to the intentions of the commanding general, and attentively following the phases of the fight, shall be sufficiently instructed in tactics to appreciate with exactness the different situations which successively present themselves; have an initiative which leads them to take of their own motion, without hesitation all the measures which lie in their province and whose necessity they perceive; and finally, a professional proficiency which enables them to make the best use in the least time of the local circumstances and the resources at their disposal. As regards the company, it is necessary that it be very well trained in earth-work as well, in order to accomplish the task assigned it in the time available as because such effort may be required of it several times in the course of the same day.

Rapidly getting to work has then a great value in the execution of field-works. While an officer traces the trench, the men receive their tools, are rapidly posted and immediately begin work. They must be accustomed, the case occurring, to modify on their own responsibility the regulation profiles, in order to get the necessary earth with the least labor: the only dimension to be considered invariable being the thickness of 80 cm. necessary to stop the bullet. Proceeding thus, you will be surprised at the results which may be obtained with a well drilled and well instructed company.

THE WINTER SEASON.

A few years ago, the time between the incorporation of the new soldiers and the end of March was devoted only to their military instruction. At

the present time it includes a certain number of sessions in technical instruction (about two per week) intended to give the recruits some notion of the special duties of the arm, with a view to the possibilities of a mobilisation occurring in the spring. We thus have at our disposal a total of thirty sessions, and must determine what use to make of them.

The first solution which occurs to the mind is, to divide the time at disposal between the different branches of instruction in proportion to the total number of sessions which each one would require in the course of a year; in order to give each young soldier a certain facility in performing all the tasks which may fall to a sapper in the course of a campaign.

But such a condition appears very difficult to attain. It can scarcely be assumed, for example, that a young soldier who has attended two or three navigation drills in the arras bridge-school, can profitably take his place in the Anchor and Boat detachment of a company throwing a ponton bridge over the Rhine, or over a much less rapid stream.

It does not appear, moreover, that the attainment of this condition is indispensable. The result which it is essential to obtain is, in effect, to have the companies constantly mobilisable, that is to say, in condition to perform all the tasks with which an engineer company may be charged in campaign; or at least to reduce as much as possible the duration of the time during which the units can not mobilise to advantage all their active elements.

Now let us take for example the school of bridges, and consider the case of a company whose recruits have two or three months service. We leave aside the sergeants and corporals, who, if they have been well instructed, ought to be ready to perform any duty whatever of their grade. Let us admit that a mobilisation occurs and that the company mobilises on its peace footing: 80 sappers, of whom 40 are new soldiers. What instruction should the latter have received in order to permit the company to build, under normal conditions, a bridge by successive pontons, if we take no account of the reserves?

Among the 40 old soldiers, the 20 best drilled in navigation will be selected to form the anchor and boat detachment; the 20 others will compose the lashing detachment. The new soldiers ought to be competent to provide for the construction of the abutments, for the side rails, and together with a few auxiliaries, for carrying the balks and chess. They can, besides, receive the necessary instruction on any pond or watercourse, the swiftness of the current having, in respect to this, no importance. It will likewise be advantageous to drill a certain number of them in lashing, in order to provide for a possible shortage in the number of old soldiers, who will, in every case, furnish the anchor and boat detachment complete. Therefore (to confine ourselves to this one example), we may ask if, in the matter of preparing engineer troops for war, instead of instructing all the new soldiers in the same way during the Winter season, with a view to giving them some proficiency—necessarily incomplete—in all their duties, it would not be better to teach each man thoroughly

some portions only of the course of instruction in order to qualify him to fill a certain number of specified positions. The instruction of the men will be completed later, during the summer season, by taking them successively through all the duties.

Carrying out the same train of thought, it does not appear necessary to give to the new soldiers, during the winter, any information on the use of explosives. The company should always have a sufficient number of instructed men to provide for this department of duty.

But there are kinds of work for which it appears indispensable that every sapper should have as great as possible an individual value; we mean the execution of field-works and above all, working in earth. For their execution, each sapper takes his place in ranks with his tool, as the infantryman with his gun, the cavalryman with his horse. That he may do his part acceptably, it is necessary that he be exercised in the defensive organization of positions and of natural accidents of the ground, in constructing passages over small streams and ditches, etc., in a word, in the execution of all the small tasks which fall to the engineers on the field of battle; above all, he must be very well trained to working in earth.

What is it, after all, which distinguishes an engineer company from an infantry company, as regards proficiency in the execution of field-works —this expression being here taken in its widest sense? Two things of very different kinds: 1st. Special technical instruction, comprising certain branches with which the infantry remains unacquainted. 2nd. Training in earth-work, which enables us to obtain a more considerable return in a given time, and above all a repetition of effort which could not be required of a man who knew how to hold a tool but was not trained.

This necessity of making vigorous earth-workers of all the sappers appears clearly when one studies closely (as we have tried to do above, à propos of field fortification), the part which engineer troops are called upon to play on the field of battle.

It is advantageous, therefore, earnestly to exercise the new soldiers, as soon as possible, in earth-work; and this not by insisting at great length on the tracing and profiling drills, but in digging the greatest amount of earth possible. It would also be useful to devote one or two drills to the rapid getting to work of which we spoke above.

Thus, to resume, there might be during the winter season, two or three bridge drills under the conditions above indicated. The rest of the time at disposal would be given to earth-work and to field-works. As for all other tasks which, in campaign, would fall upon the engineers, it would seem that the company could always acquit itself acceptably, without requiring the new soldiers to take part otherwise than as combatants or workmen; above all if account is taken, in regulating the details of instruction during the summer season, of the vacancies annually produced by the liberation of a class.

APPENDIX.

Several times in the course of the present study we have alluded to the restricted time which is available, in engineer regiments, for properly carrying on the instruction of the troops and, whatever may be the zeal and devotion of the officers, and whatever efforts may be imposed upon the men, it is to be feared that the difficulties which result from it can not be completely obviated.

Is it possible to apply a truly efficacious remedy to the situation by attacking directly the causes of its existence?

The study of such a question passes so far beyond our competence that we would hesitate to treat it, if we did not consider it as an imperious duty for every officer to seek to contribute, according to his ability, however little that may be, to the progress which should be the constant law of our military organization.

Two principal causes tend to reduce the time available for instruction:

1st. The great number of special duty men which the companies furnish.

2nd. The multiplicity of functions of the arm.

The first of these causes has two equally regrettable results:

(*a*). By considerably reducing the number of men available for work and drill, they render impossible the execution by company of certain drills which require a definite number of men, such as, for example, ponton bridge construction; it consequently obliges recourse to be had to drill-companies, a proceeding which, although in certain cases prefecting the instruction of the unit, constitutes a poor means of individual instruction.

(*b*). In comparison with the men who serve three years those who, according to the popular expression "do their service" in only two years are much less numerous; almost all are special duty men from the end of the first year, some men from the month of April, as soon as their military instruction is completed.

It can be said, therefore, with truth, that there is only a single year or rather ten months available for instructing the men; as much for those who are bound for three years military service, as for those who have only one. All engineer officers who have served in engineer regiments will appreciate the difficulties which are experienced in devoting sufficient time to every part of the instruction in so short a period.

It does not seem from this point of view that the situation can be sensibly modified, except by a radical change in our military organization; for several years, indeed, the general inspectors, chief of corps, etc., have made efforts to reduce the number of clerks. Certainly the results obtained are appreciable, but it will be admitted that nothing much remains to be done in this quarter and the small number of men which might perhaps be returned to the ranks would scarcely work any change in the present state of affairs.

Let us return to the functions of the arm.

These latter, already numerous for several years, were increased still further by an important service when, by the suppression of the regiments of pontoniers, the engineer troops were charged with the construction of ponton bridges. The result of it is a sensible diminution in the number of sessions which can be devoted to each of the different schools.

It may be asked, then, if all engineer troops, except the railroad and balloon regiments, should be drilled in ponton bridge building, or if it would not be preferable, on the contrary, to specialize a certain number of units, charging, for example with this duty the corps companies of the service, the other companies (divisionary and garrison), continuing to receive the same instruction as in the past.

Up to the present the first solution has prevailed, with the exception of the assignment of the companies on mobilization; in consequence of the certain differences in the methods of instruction applied and the time devoted to each school, none of them has been completely specialized.

To the increase in duties of engineer troops there has been no corresponding increase in effective strength; the number of companies remaining about the same, it would appear to be a difficult matter to separate a sufficient number of these to provide for the new service without the other attributes of the arm suffering.

But one is confronted by other difficulties. The old engineer garrisons—Arras, Grenoble, Montpellier, Versailles—were chosen at a time when there was no question of ponton-bridge duty for this arm; the result of this now is, that the troops must be displaced and sent to large streams where the breadth and rapidity of current will permit them to perfect this instruction, which can only be outlined at their garrisons.

Now this instruction thus completed takes a considerable time, necessarily to the detriment of other schools which have their importance also, and which one would be afraid to see somewhat neglected, since, for certain units they constitute the essential part of the instruction; this is the case, for example, as regards saps and mines for siege companies. The school of mines, notably, in order to be taught properly demands considerable time, so that, with three years service it is difficult to make at the same time of a single engineer soldier, a well drilled miner and an accomplished pontonier.

At first sight, specialization seems to permit the situation to be remedied; whether it is applied to the soldier in the company or to the companies themselves, the result would be identical as far as the subject with which we are engaged is concerned, namely, the reduction of the number of subjects to be taught each soldier, thus allowing a more considerable time to be devoted to each of them.

We propose, therefore, in what follows, to examine whether this measure appears compatible with a good preparation of engineer troops for war; in the case of the affirmative, whether it should be applied to individual men or to units and under what conditions.

SAPS AND MINES.

Amongst the duties of engineer troops, saps and mines were formerly the most important, as is shown by the name "sapper and miner" still in use. Since then, the employment of these works has been considerably modified and has sensibly diminished, at least in the regular and almost rigid forms formerly affected. On the other hand, the greater part of the engineer troops go now, in case of mobilization, to the field armies, so that the school of saps and mines has little by little lost the predominant place which it formerly held in the instruction.

Is it to be believed as we sometimes hear, that the powerful effects of modern siege artillery will do away in the future with the slow attack foot by foot? It would seem likely that when one has to do with an antiquated fortress, incomplete or badly defended, a case which will, undoubtedly frequently present itself, that it ought not to be the same with a fortress well prepared for defense and provided with a sufficient garrison.

By well fortified fortresses, we understand those, in particular, whose essential close defence works, that is to say those which flank the works and their intervals, can not be destroyed from a distance by artillery and remain in an efficient state, even after the most violent bombardment.

Is the building of such a fortification possible in the presence of modern artillery? Without entering into a technical discussion which would lead us much too far, we will say only that the affirmative appears to us certain; it is prudent to assume it in every case. The assailant who attacks such a fortress will have to choose between a blockade and a regular siege.

Now, of what will the works of approach consist which will have to be built in the sieges of the future? It seems that they may be arraaged under two entirely different categories.

Until a certain distance from the fortress has been reached—a distance which will vary according to circumstances—these works will consist of putting the positions successively occupied by the assailant in a state of defense; the latter will improve the natural covers and will dig deep trenches furnished with frequent shelters.

Communications hidden from view and the different works of approach will depend as much as possible on one another against sorties of the defender.

The execution of all these works constitutes, in reality, very solid battlefield intrenchments; the infantry will take a large part in the works; as to the engineer companies who would be equally employed, they would scarcely have to apply any of the dispositions of the school of saps, still less those of mines.

When the assailant has reached assaulting distance two cases may present themselves:

Either the artillery of the attack will have destroyed the works, flanked the works and their intervals itself, or it will have breached a broad passage through the accessory defenses, military fences, and all disposition susceptible of stopping the assailant and the fire of the defender; if the latter apears then to be sufficiently weakened and demoralized, the assault may be made at once.

But the artillery may not have had a completely effective action on the essential parts of the fortification, as well as on the principal objects which oppose the work of the attacking columns; in this case the assailant ought to push his approach works into contact with the permanent works, in order to accomplish with the mine the destruction commenced by the cannon.

The distance of the assault itself is very variable; it depends on many factors, of which the most important is certainly the defender. If the latter, in spite of the losses and privations of a siege which is bordering on its last period, has remained active and energetic, an assault delivered from a distance may lead to a disaster. At the moment when the artillery of the attack stops its fire in order not to touch friendly troops, if the defender can man his ruined parapets with a line of riflemen and can succeed in mounting on them a battery of a few rapid-fire guns, then the assailant may suffer a very deadly check. The histories of past wars offer many examples of this kind, which would be still more grave in our time, by reason of the efficiency of modern arms. It will be necessary, in this case, to bring the troops of the assault to the nearest possible cover to their objective. It is certain that the execution of the necessary approach works, in the immediate proximity of the fortification, as well as making use of the explosives destined to throw down the concrete counter-scarps and destroy the flanking casemates, and the struggle, if there should be one, against the counter-mines of the defender, will be of very delicate execution and would demand special instruction which would not be required in the preparation of works of approach at some distance from the permanent work.

When the attack will have found it necessary to push works as far as we have indicated above, the defender will have found a way of retarding them in a subterranean war properly carried on with all the modern means of attack and defense.

It would seem, therefore, that in this last stage of the siege—which might happen in certain cases—the employment of engineer companies specially trained as regards the part they would have to play, might be justified. But if we are bound to admit that the regular attack of a well fortified place may require the execution of the works of which we have spoken, it is permissable to consider such a case if not as exceptional, at least as so infrequent as not to provide for the employment of a great number of engineer companies who have received the necessary special instruction. Our present siege companies plus, of course, the reserve and corresponding territorial companies—ought to enable us to fulfill this task well, as much to defend our own fortresses, the case happening, as to attack those of the enemy, if a fortunate war should offer the occasion.

It may be asked, therefore, if we should completely specialize our engineer companies into siege and field companies both in instruction and duties.

Siege corps and garrisons of fortified places would comprise engineer troops of two specialties, those pertaining to field-work being specially charged with all that concerns communication (roads, bridges, etc.) and, it being especially necessary, with the construction of ponton bridges. Concurrently with the siege companies, they would work to put fortresses in a state of defense, and in the preparation of approach positions occupied beyond a certain distance from the work.

With the exception of that part of the school of mines, which relates to field-war, that is to say, the use of explosives in demolitions, effecting breaches in walls, accessory defenses, etc., the school of saps and the school of mines could then disappear from the program of instruction of field companies. The least that is now possible to teach them, appears moreover, to be insufficient to fit them for any other role than that of auxiliaries in the attack or close defense of a fortification. On the other hand, in the defense of a place, it does not seem that it would be very useful to them for the organization of the first line of resistance, any more than in the attack for the execution of the approach works which are not in the immediate vicinity of the permanent works.

On the other hand, the school of saps and mines would become the essential part of the instruction of the siege companies. This instruction would comprise, besides, field fortifications, but the school of bridges would be taught only to field companies.

BRIDGES.

As we have mentioned above, most of the posts of engineer regiments would not be suitable for completing their instruction in ponton-bridge building. It is therefore indispensable every year to send a certain number of units, in order to complete their instruction, to a water course of sufficient breadth and velocity of current.

In this connection one may hesitate amongst many methods of procedure; in fact, during the last few years, diverse methods have been employed, differing amongst themselves as much in consequence of the troops displaced as of the nature of the water-course.

Since we have lost the Rhine, the Rhone is the only one of our rivers which realizes the most favorable conditions for the instruction of pontoniers. A bottom very hard, consequently offering little hold for anchors, great breadth, rapid current, it unites all difficulties which one may have to overcome.

The ideal arrangement would be every year to send to this river, for a certain time, all companies which would be called upon to concur in ponton bridge service.

But there would be to this arrangement two obstacles, at least with the present organization which does not permit of specialization of companies.

The first is an obligatory expense; the regiments of Arras, Versailles, Angus, being posted in fortified towns far from the Rhone, the necessary movement of troops by railroad would be very onerous and ought to be reduced to the strictly indispensable; the barrack arrangements on the shores of the Rhone are very limited, it would be necessary in order to send annually all the companies to this river for a sufficient time to increase these resources to a notable extent; a new expense would be the result which we ought to seek to avoid.

The second objection is that the instruction thus given would take much time and the number of lessons which would remain available for other schools would undoubtedly be insufficient.

A first solution, which has been practiced, consists in sending to the Rhone only a certain number of chosen men, forming for each regiment a drill company, the others completing their instruction on a river situated relatively in the proximity of their garrison, the Seine at Elbeuf, for example, for the Arras and Versailles regiments.

This method of procedure, although it avoided in part the first of these difficulties, did not affect the others; this is undoubtedly the principal reason why it has been replaced by another; under this arrangement the Rhone is no longer utilized for the finishing instruction, but each regiment sends every year to this river drill companies formed in the ratio of one to each battalion, and to which the divisionary and corps companies furnish each forty men specialized as pontoniers, the others being specialized as miners.*

If the respective advantages and disadvantages of these two methods of instruction be compared, it will immediately be noticed that in the first, instruction is by company, which is not an appreciable advantage. By taking the precaution to detail for the drill company to be sent to the Rhone, a great enough number of non-commissioned officers and lance corporals, the captains would provide themselves with a sufficient number of pilots familiar with the navigation of rapid currents. But even if one could count on these pilots being properly drilled for building a bridge on such a river as the Rhine or the Rhone, it is to be feared that it would be different with the crews, a great number of whose men would have to do with such a rapid current for the first time.

The second solution, on the other hand, seems, at first sight to provide each field company with a sufficient number of drilled men to form a detachment of "anchors and boats" capable of navigating any stream without hesitation.

But in this case the instruction is not carried on by their captain but by all the officers of the regiment who are called upon in turn to supervise the construction of the bridges. This is one of the most serious difficulties, whose gravity is revealed as soon as we examine in detail the way in which the instruction is given.

The drill companies have to supply a guard, police, etc., which absorbs a certain number of men; among these there are some who are never relieved (buglers, orderlies, telegraph operators, bicyclists, cooks, etc.) These details already reduce the number of trained men which the bridge drills ought to provide for each company. As to the others, it is easy to see that they are far from receiving uniform instruction.

The officers of the regiment other than those detailed with the drill companies, pass about eight days on the Rhone, in the course of which each of them is called upon to take charge of two or three drills. Very properly, their great care is that the operations intrusted to them are executed with the greatest possible exactness; for this purpose, they order the officers who are their assistants to choose their non-commissioned officers. The result necessarily is that the pilots (steersmen), who during the first days have distinguished themselves for skill and coolness, are always placed at the posts offering some difficulty and,

* Besides, this specialization is only partial, since it concerns only the finishing instruction, the engineer soldiers belonging to the field companies receiving in the beginning, elementary instruction which gives them some idea both of the school of mines and that of bridges. We may remark in this connection the difficulties which attend the finishing instruction given under these conditions to the miners of the field companies The number of this latter who receive this instruction is sure to be very small, after each company has reduced its available strength by the forty men who go to the bridge manœuvres, since ordinarily the number of men that these same companies would send daily to drill would very exceptionally reach forty.

which are consequently, instructive; to the others fall permanently the lashing of the side-rails, the construction of the abutment bay and especially the carrying of the balk and chess. In their turn, the men are divided up in the same manner by the non-commissioned officers who form the detachment under their orders according to the aptitude which they have noticed in their subordinates. Even should they wish it, it would be scarcely possible for the officers, who are being constantly changed, to establish a rotation of duties which would cause all to pass a few times through the different posts.

The result is that in each company, the number of men really broken to the difficulties which a rapid current presents to the construction of a ponton bridge would be greatly reduced; from forty which it ought to be, it falls to twenty, fifteen or even less.

Here again, we appreciate the defects of instruction given to men in special platoons, drill-companies, etc, in short anywhere except in their own company.

Neither of the two methods of instruction successively employed seems therefore absolutely satisfactory, and it does not seem easy with the present organization of engineer troops, to find a solution which satisfies the necessities of proper instruction and the demand of economy. It is particularly difficult to avoid the difficulty which results from the fact that the bridge service being justly considered as of the highest importance, all the field companies have come to devote to it so long a time that other parts of the instruction suffer in a very sensible manner.

It may then be asked if, under these conditions, it would not be preferable to specialize a part of these companies as companies of pontoniers admitting, however, that such a measure would not be incompatible with the part which engineer troops as they are now organized in the army corps are called upon to play in a campaign. Now, if one of the engineer companies attached to each army corps be specialized as a pontonier company, it is natural that it should be the corps company. Will not this company always be in a position to perform, completely and alone, all duties connected with the bridge equipage?

Let us consider the most unfavorable case; namely, that of the army corps marching on two roads with a division of the bridge train in each column; the two bridges which could be constructed in such a case could be easily done by a platoon of the corps company, provided the operation required, at the most, for each of the bridges, only 97 men, of whom 28 (the detachment of balks and chess) could be any auxiliaries whatever. If an advance guard bridge equipage marches at the head of each column its service could easily be assured by a section of the corps company.

In a word, the available strength of that company, even supposed reduced almost by half will be sufficient in every case, to handle, under normal conditions, all the material of the bridge equipage belonging to the army corps; the essential thing is that it should be within reach Now, it is certain, by reason of the respective places which these units occupy in the columns, that the corps company will be able to reach the site of the bridge to be constructed at least as quickly as the bridge equipage.

Thus, as far as the service of the bridge equipage is concerned, it does not seem that there would be any difficulty in the corps company's being exclusively charged with it, and, consequently, alone receiving the corresponding instruction.*

Many officers, moreover, expected the present condition of affairs, at the time of the suppression of the pontonier regiments, which some would have wished to see reorganized at Angus and at Avignon by collecting, in these garrisons, third companies of the engineer battalions.

It seems that this last disposition would have been unfavorable from more than one point of view; the corps companies forming distinct regiments and alone charged with the service of the bridge equipage, would have allowed themselves little by little to be absorbed by this part of the instruction, considering the others as accessories. Under these conditions, indeed, there would have remained in the army corps only the divisionary companies, to attend to all the duties which fell to the engineers before the suppression of the pontonier regiments, which would have been absolutely insufficient.

There is another point of prime importance, which is, that the engineer troops who, at mobilization are attached to the same army corps, should constitute the same unit in time of peace.

Thus specialized, the corps companies would be the only ones that it would be necessary to send to the Rhone to finish their instruction; and this could more advantageously be done

* In order to treat the question in an absolutely complete manner, it would be necessary to discuss the influence of such a measure on the formation of the reserve, but a study of this nature would not be in place here; we may say only that the sole consequence which should result from it would be the necessity of observing, in the composition of the reserve companies, some ratio between the respective numbers of the men who have served in the corps companies and those coming from the divisionary companies; it does not seem that any difficulty would result from this fact.

since separate detachments would no longer be grouped into drill-companies, but the companies would remain complete under the command of their captain who alone is responsible for the instruction of his unit.

These companies would not be, on account of this, only pontonier companies. Their special instruction relating to the last duty, however completely it might be given, could not absorb all the time available outside of the regular military instruction. The program of instruction of the corps companies should therefore comprise the use of explosives as well as field fortifications.

Thus the days when the corps companies would not act as pontonier companies—which would be the general case—they could be employed on the part of that instruction which relates to establishing or breaking lines of communication as well as battlefield works.*

FIELD FORTIFICATIONS.

The result of the above considerations relating to saps, mines and bridges, supposing the engineer companies specialized under the conditions indicated, would be that field fortification would become an attribute common to all companies. It would only be necessary to consider the effect of this arrangement on the mobilization, and regulate accordingly the details of the instruction given to each of them. Thus, for example, the divisionary companies, having no longer to deal with saps, mines or the bridge equipage, could consequently devote considerable time to battlefield works, and would profit by it to push as far as possible their training in earth-work, rapid laying out and preparation for the work, and especially drills on varied ground; these last are, indeed, the only ones which could enable them to study in detail the works of as varied a nature as would fall to their share on the battlefield, when they act in conjunction with the infantry.

We have set forth, in this appendix, the reasons which appear to militate in favor of the specialization of engineer troops; other considerations which perhaps have escaped us may be opposed to the adoption of this measure; so, leaving this to others more competent and experienced than ourselves, let us be careful, in terminating, not to draw a settled conclusion which might appear rash on our part; our object will be attained if, by submitting this work to our chiefs and our comrades, we have made a useful, although modest contribution to the study of this question, the most important for the arm of the service to which we have the honor of belonging, that is to say, the preparation of engineer troops for war.

* The specialization of the corps companies as companies of pontoniers, above outlined, would not merit the reproach of being a return pure and simple to the old organization, for it would not present the two essential difficulties which were to be found in this latter, viz.:

1st. All the engineer troops, having charge of communication, in the army corps, were not united under the same commander.

2nd. The pontonier company could only be utilized for the construction of bridges.

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BY

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IN 1872, the improvement of the Mississippi River, between the Missouri and Ohio Rivers was begun in accordance with the provisions of the River and Harbor Bill for that year, which carried an appropriation of $100,000 for beginning the work.

The Mississippi River, above the mouth of the Missouri, is a comparatively clear stream flowing in a fairly stable bed. The Missouri, however, comes in heavily laden with sediment and the whole character of the Missisippi below their juncture changes. The bed and banks are chiefly of alluvial deposits, and as a rule, are easily eroded, causing constant changes in the position of the principal current and consequently a constant shifting of the whole bed of the stream.

The low water discharge at St. Louis, about 16 miles below the mouth of the Missouri, is about 30,000 cubic feet per second, the ordinary flood discharge is about 750,000 and the maximum known discharge is about 1,200,000 the mean discharge being 225,000, of which the Missouri brings in somewhat over one-half.

The slope in the reach under consideration averages .44 of a foot per mile, but varies between one-half to double this amount. The river in its unimproved state varies from .5 to 1.5 miles in width and meanders from one side to the other in an unstable bed, between bluffs from 3 to 8 miles apart, for a distance of about 160 miles. Thence it flows for a short distance through a gorge and emerges at Commerce, Missouri, into the alluvial valley of the lower Mississippi.

The variation in level at St. Louis ranges between limits about 35 feet apart, ordinarily, but the highest known flood (in 1844), rose 42.5 feet above extreme low water.

The high water season is generally from March to July, low stages prevailing the remainder of the year.

From December 1st. to March 1st., navigation is usually suspended on account of ice.

Work upon this stretch of river was begun, as stated, in 1872, under the direction of Col. J. H. Simpson, Corps of Engineers. For the first two or three years, the work done was directed mainly toward the improvement of St. Louis harbor, several stone dikes constructed for the improvement of Horsetail Bar being the only work of importance, other than surveys, done outside of this locality. A complete triangulation was made of the portion of the river between the Missouri and the Ohio, and in 1875, a project was prepared and approved for the improvement of this reach, to obtain a depth of 6 feet above and 8 feet below St. Louis, at low stages of the river. This project contemplated the improvement of the worst bars first, so as to afford the earliest possible relief to navigation, and the means proposed were contraction works, consisting of stone and brush dikes and training walls, supplemented by the revetment of caving banks. The work was to be done mainly by hired labor, only work whose character and extent could be definitely fixed beforehand being done by contract. This policy has been consistently followed throughout the whole work. The estimated cost of the work needed under this project was $3,159,200 for dikes and dams, and $4,000,000 for bank protection and maintenance.

In accordance with this project work was begun at several of the worst localities, the work being chiefly of three kinds; 1st, the revetment of such banks as were most in need of protection; 2d, the construction of low stone and brush dams to close chutes around islands and tow heads; and, 3d, the construction of stone and brush dikes to effect contraction of the stream. Contraction dikes were constructed only at Horsetail and were connected by a longitudinal training wall. These works did not entirely accomplish what had been expected from them in the way of causing deposits and, in 1879, pile and brush hurdles were placed between the dikes about 100 yards apart, to hasten deposits. The deposit of material was hastened by these hurdles so effectively that it was evident that stone cross dikes and dams might be dispensed with entirely and their construction was, in 1880-81, discontinued, hurdles being built in their stead.

The project of 1875 was modified in 1881, the principal difference being the change in policy as to the order in which improvements were to be made. It was determined to carry on the work continuously from St. Louis down stream, instead of first improving localities at which navigation was most obstructed. Changes in forms of construction were also introduced, hurdles being substituted for solid dikes and dams as above stated, and mattress being employed for protection of banks below low water in lieu of foot walls.

In accordance with this project, work has been progressing from St. Louis and is now being carried on throughout the whole reach. The work now going on consists chiefly of bank protection and an extension of the contraction works in shoal portions of the river not yet brought to the adopted width of 2500 feet. Pending the completion of the permanent improvement, the low water channel is to be improved each season by the use of dredges and other temporary expedients. The original estimate of the cost of the improvement, as revised in 1883, is $16,397,500. The total amount expended to June 30, 1901, was $9,485,219.34. The result of this expenditure has been the partial improvement of the whole reach between St. Louis and Cairo. During the last year, the least channel depth was 6 feet, except for a few days when it fell to 5. The improvement is continuous for 60 miles below St. Louis, but is not complete at any point, and in the lower section, work has been confined to the points which cause most trouble to navigation. It is believed that there can be no doubt of the ultimate success of the permanent improvement, and it is expected that with the present appliances for the temporary improvement of low water channels, a depth of at least 6 feet can be maintained between St. Louis and Cairo until the projected depth of 8 feet is obtained through the extension and completion of the permanent works.

In order to properly appreciate the principles which should govern any attempt to improve an alluvial stream by regulation, it is necessary to have some idea of the natural causes which operate to produce the conditions found in the beds of such rivers.

A stream flowing through soil which is capable of erosion by water flowing at the velocity found in the stream will not follow a straight course; irregularities in the bed, by deflecting the current to one side, cause a greater local erosion of one bank than of the other and a slight curve is formed. The current passing nearer the concave bank, this curviture is increased by further erosion and at the same time the current being deflected by the curve to the opposite bank cuts out a reverse curve below. Thus the river finally makes for its bed

a series of bends which go on increasing in curvature until the river bed is lengthened sufficiently to reduce the slope below that value which, taken in connection with the cross section of the river, will cause its bed to be eroded, and the latter will then become stable.

This condition of equilibrium might be quickly obtained by a river constant in its discharge or varying through small limits, but in the case of a great river, with variations in its discharge such as are found in the Mississippi, it is evident that a position which gives a condition of equilibrium for one stage is not at all the same as that for some other higher or lower stage. Were it possible to fix and hold for the river a cross section such that every stage of the river should have its proper normal profile width as defined by Schlichting, then the ideal would be reached; but it is hardly necessary to point out the impossibility of effecting such a condition in the case of the Mississippi. The most that can be done, and the most that it is really necessary to do, is to construct such works as will hold the river during its lower stages in the bed which it has made for itself and prevent it, during its high stages, from cutting a new channel and entirely forsaking the old.

Simultaneously with the changes in the banks of the river due to erosion or deposit we find similar change in the river bottom, pools being dug out of greater or less length, separated by bars formed of the sediment deposited by the river.

These bars and pools are formed by the river chiefly during its high stages, while the action of the water as it falls, tends to reduce the differences in level of the river bottom. This is quite forcibly illustrated by the fact that soundings on the Horsetail Bar below St. Louis, during high water in 1877, showed that the bottom of the river had been raised to a height of ten feet above low water. The bars are formed wherever, owing to an increased high water cross section normal to the current, the velocity of flow is checked, causing a deposit of sediment. Pools are formed where the opposite conditions prevail. Deeper water is, as a rule, found in the curved portions of the bed along the concave bank, the reason being that the shape of the curve throws the current into the concave bank and the contracted current sets up an erosion which is intensified by eddy currents. In straight reaches, on the other hand, and in crossings from a pool near one bank to one near the other, the bars are found, due to the fact that the current, which was in the former case found along one bank, now spreads more or less uniformly over a much greater cross section, with a correspondingly reduced velocity.

The origin of bars thus formed is the material rolled along the bottom by the stream, that part which is carried in suspension playing a much less important part. It is therefore chiefly local in origin, the material forming any one bar having been recently removed from the bottom or the banks not far above.

To obtain and maintain a good navigable channel the following requirements are given by General Simpson, (Annual Report of Chief of Engineers, 1875, part 2, page 485):—

1st Sufficient depth at all stages.
2d A judicious location.
3d Stability in position.
4th Facility of approach to landings.
5th Easy changes of direction.
6th Moderate velocity of current.

There have been many advocates of confining attention to the amelioration of the low water channel as it appears each year. This would be done by opening a channel by dredges, portable jetties, or otherwise through each reef as it appears, trusting to the current to maintain it until next high water. This might be possible were the reefs always fixed in position, but the continual shifting of the reefs makes it almost certain that the channel will be quickly filled and consequently it would be necessary to open it a number of times each season. In striving to secure a given depth in a stream we must work toward it through one or more of its correlated elements, width, volume and velocity. The volume of discharge is of course not subject to our control and must be accepted as found. For a given width a reduction in velocity would necessitate an increase in depth. Such a reduction would also be desirable as diminishing the sediment bearing powers of the stream. But the velocity is a function of the slope and the hydraulic radius, and as an increase in depth involves an increase in the hydraulic radius, it follows that the velocity can only be reduced by reducing the slope. A reduction of the slope can be obtained by lowering the water level at the upper end of the

reach or by increasing the length of the reach. A reduction of slope, by lowering the level of the upper end, is always a consequence rather than a cause of river improvement and is to be avoided as much as possible, as it necessitates a reduction in the depths above the improved portion. One result of the improvements under consideration in this paper has been the lowering of the low water level at St. Louis. Exactly how much this lowering has been, can not be determined from the insufficient data available but it is believed to be about 2.5 feet. The lengthening of the river as a means of reducing the slope, can, of course, be effected only to a very small degree and is touched upon chiefly to show the undesirability of shortening the stream in any way and to furnish an additional reason for preserving easy curves and avoiding cut-offs.

This leaves us then the element of width as the only one within the range of control by modifications of which the river may be induced to cut itself a deep channel. Contraction of excessive widths is then the easiest and most practiable method of securing the desired depths.

The second requirement, the judicious location of the improved channel, is best secured by following the natural tendencies of the river and endeavoring to hold the river in the course which it has worked out for itself rather than by attempting to force any violent change in its course. It is a well known fact that any great and sudden change made in the channel of a stream upsets its regimen for a long stretch above, and a considerable time must elapse before a condition of equilibrium is resumed. It is stated that the Mississippi River, above Kaskaskia, has not yet entirely accommodated itself to the conditions brought about by the Kaskaskia cut-off by which the channel was shortened 5 or 6 miles in 1881.

The objections to straightening the channel, a method which formerly had its advocates, have been stated already. The suggestion that the channel should be made to follow the bluff has in its favor only the fact that one side of the stream would be hard and unyielding and would therefore need no protection. To offset this advantage which is more apparent than real, we have the fact that as the bluffs are approximately straight this proposition meets with the same objections as the one just mentioned. Any considerable changes made in the location of the channel would also greatly disturb existing business relations. The advisability of following existing channels is thus in accordance with policy as well as with engineering considerations. The third requirement, stability in position, is essential to the establishment of facilities for trade. The necessity for the channel following a fixed line needs no demonstration. But this stability in position must be taken to refer not only to the axis of the current but also to the bars.

The positions of the bars in the natural river are constantly changing. The sand proceeds slowly down stream in waves. If, as the result of works of improvement, these reefs or bars can be made to remain in definite localities, if the bars can be fixed in position, then their improvement either by permanent works or dredging is a much easier problem and can be undertaken with the assurance that your bar will not elude your improvement work by moving down stream.

The fourth requirement, facility of approach to established landings, should really be considered as a part of the second requirement, i. e. the judicious location of the channel. This requirement is often in conflict with an easy solution of the problem from an engineering point of view but it is a requirement of considerable importance and must be given its full weight in deciding between different lines of improvement works for a given locality.

The fifth requirement, that changes of direction should be easy, is in the interest not only of stability but also of easy navigation. However, these changes of direction should not be too easy. A channel maintains its depth best along a curve, but if the curve is too flat the channel will not follow the concave bank throughout and the difficulties met with in the straight reaches are encountered. If, on the other hand, the curve be too sharp, erosion of the concave bank is greater, bank protection is more costly and navigation more difficult. The proper radius of curvature differs for different streams and must be separately determined for any given one. Thus a radius of from 5000 to 10000 yards might be proper for the Mississippi, while such a radius would be entirely too great for a smaller stream.

The sixth and last requirement, that the velocity shall be moderate, does not in the case of the Mississippi call for any work especially designed to meet it.

If the contraction works are kept to their proper dimensions the velocity will not be so excessive as to impede navigation.

The methods which have been followed on the Mississippi river between St. Louis and Cairo for meeting these requirements have been mainly contraction works and bank protection.

The object of contraction works is to so reduce the width of the river as to force it to scour out for itself a deeper channel in order to secure a cross section sufficient to carry its volume of discharge. The width to which the river was to be contracted was fixed at about 2500 feet. Dikes or dams closing side chutes around islands or toeheads are included under the head of contraction works as both their purpose and their result are to contract the waterway.

The bank protection was intended, of course, to protect the banks against erosion, there being two reasons why the erosion of the banks should be prevented: 1st, in order to hold the channel in a fixed position by preserving the bank itself; and, 2d, in order to cut off as much as possible the supply of bar forming material.

The chief question to be decided in each locality in which contraction works are put concerns the line which the channel must be made to follow. In studying the works already placed in the portion of the river under consideration, we find instances of both the right way and the wrong way to place them. As is well known, whenever a river flows around a curve the channel is always in a fixed position, and we find that wherever contraction works have been placed on the convex bank, and bank protection on the concave, good results have invariably followed. Other considerations, more practical and less theoretical, but equally important, support the same method i. e. the considerations of ease of construction and of cost. The convex side of the river, being less deep than the concave and having a less velocity of current, contraction works are more easily constructed and more efficient in causing deposits than when placed on the concave side.

In straight reaches in need of contraction the works should, if practicable, be so placed as to change the reach from a straight one to one having a succession of curves. When this has been done the results are as good as in the former case. But where the works are so placed as to flatten out curves, converting them into almost straight reaches, or where straight reaches already in existence are preserved, the result has been a channel which is constantly shifting in position and frequently insufficient in depth.

Another very important result of the river's following a series of curves instead of a straight reach is the permanence secured in the position of the bars. As bars will occur only at the crossings, their position is definitely known and if the works are properly designed they will rarely interfere with the projected depth, and at such times as they do give trouble a little dredging will give prompt and sure relief.

It follows then that the requirement of sufficient depth at all stages, as well as that of stability of position, is best fulfilled by placing the contraction works so as to guide the channel as far as possible into a series of easy curves. Incidentally this also slightly increases the length which has been mentioned as a desirable end to be attained.

The use of ground sills has found no place in the scheme of improvement followed thus far. The action of ground sills is to ultimately raise the level of the bottom in the pools and thus increase the slope in these places. As an increase of slope in one place necessitates diminution in another, the final result is to make the slope more uniform. During the formation of the deposits necessary to raise the river bottom the sills act as submerged dams and effect the same results. This system has been followed successfully with many European rivers, especially with the Rhone, where the drop of over 4 feet in the low water level at La Mulatiere, due to previous improvements below has been, in a measure, regained. The use of such a system seems hardly necessary with the Mississippi as the slope is not very excessive and the results obtained from contraction of the width and protection of the banks justify the expectations that the projected depth can be obtained by these means alone. Moreover, the use of ground sills would involve great expense on account of the width of the river and the great depths of water in which they would have to be placed. Works of this nature in the reach under consideration being founded on an unstable bottom would also be quite vulnerable to attack by the violent floods which occur, as is seen from the damages caused to the stone dikes and dams at first constructed.

In beginning the work of improvement of the river, Gen. Simpson determined upon the amelioration of the worst bars first and made his estimate apparently on the supposition that the removal of the bars then in existance would bring about the projected depth at once. He

evidently underestimated the effect which would be produced by the improvement of one locality on the river above and below. Bars act as submerged dams separating pools of slight slope, and the lowering of one of these dams lowers the water in the preceding pool, increases the slope at the preceding bar and aggravates such bad conditions as may be found there already or, in many cases, produces bad bars where the depth had previously been sufficient.

Bars lower down the river are also built up by the deposit of material scoured from the bar under improvement. Thus the improvement of one bar forces an extension of the works in both directions and to a degree which can hardly have been foreseen. Sufficient allowance for this was not made in the original estimate and later, in 1883, the estimate was more than doubled.

In the project of 1881 the order in which the work was to be done was changed and it was decided to proceed with the work uniformly down the river from St. Louis. From an engineering point of view the question as to whether the original improvement should have proceeded from St. Louis down the river or from Cairo up, is an open one, but at this time practical considerations due to the fact that most of the work which had been done was in the vicinity of St. Louis were undoubtedly sufficient to justify the order of work adopted.

TYPES OF CONSTRUCTION.

The contraction works first used in 1874 consisted of spur dikes, each dike being a riprap of stone built 8 feet above low water and superposed on a foundation or platform of brush from 2 to 5 feet in thickness and varying in width to suit the height of the dike, held in place by piles until loaded, an apron of brush about 2 feet thick also held in position by piles and stone having been previously laid below and alongside the dike, though not connected with it, to prevent the dike from being undermined by the fall of water over it. The dikes were 3 feet wide at the top and the stone took its natural slope. Where such a dike was constructed on an alluvial bank it was carried back 200 feet over the bank. The bank was further protected by a longitudinal dike 250 feet long, with cross dikes 100 feet long, running back on the shore at its ends.

Dams closing sloughs were similar in construction. The design was modified, in some instances, by constructing the dike of alternate layers of brush and stone instead of a mound of stone on one layer of brush and with this and other slight modifications was continued in use until about 1881.

It was intended to connect the channel ends of the cross dikes by a training wall as soon as deposits were made, and one was built at Horsetail Bar but was never fully completed.

Stone dikes thus constructed were found not to be so efficient in causing deposits as had been desired and expected; so, in 1879, a number of hurdles were interpolated between them to hasten the deposit of sediment. The results obtained were very satisfactory and in 1881, the old dikes having proved costly to build and difficult to maintain and not being very efficient, it was determined to rely entirely upon hurdles, and contraction works undertaken since then have been hurdles alone.

The hurdles built in 1879 consisted of a row of light piles about 5 feet apart, connected together by weaving or wattling willow poles between them and pushing willow brush vertically into the interstices of the wattling. The top of this brush projected about 8 feet above low water while the lower courses of the wattling could not be forced down lower than 8 feet below low water. The cost was about 80 cents per lineal foot. These hurdles were frail in design and were not expected to last more than one season. Where the water was too deep to drive these piles and construct the hurdles in position a curtain of woven willow poles and brush was constructed. The lower edge of this curtain was then anchored either to a horizontal mattress or directly to the bottom and the upper edge supported by buoys. Longitudinal walls built of hurdles were known as primary, and cross dikes as secondary hurdles. As the use of hurdles was continued the designs were modified and improved, and changes were made which rendered them stronger and more permanent, the present hurdle being finally evolved. The present hurdle consists of a row or parallel rows of three pile clumps spaced 8 to 12 feet apart, the piles in each clump being drawn together and fastened at the top by a wire cable. Where the water is shoal and the current weak a single row of clumps is usually sufficient; under other circumstances the clumps are staggered in such a way that longitudinal stringers can be placed between the rows to transmit and distribute strains. One pile

in each clump in the upstream row reaches the level of the 25 foot stage, the other piles in the first and second rows being 5 feet lower, while the remaining rows are 5 lower still.

The foundation mattress varies in width from 75 to 100 feet, about 35 feet forming an apron on the upstream side. Extra stone is always thrown around the feet of the piles to prevent scour where the mattress is broken by driving the pile through it.

The channel ends of the hurdle are protected by T heads of two rows of clumps projecting 50 feet above and 100 feet below the hurdle, the foundation being a mattress 120 feet by 300 feet. Buttresses of stone are placed at the channel ends, and the shore ends are protected by revetments for about 300 feet; drift collected above the hurdles is sunk by laying on top of it a sort of mattress of brush as evenly and rapidly as possible and then weighting the whole with stone. A curtain of brush is constructed and supported by the piling where no drift occurs. As soon as the hurdles caused a deposit reaching about the 17 foot stage, willows began to grow and by checking the velocity of high water caused further deposits to be made. The artificial banks thus formed may be protected as described for natural banks. The distances apart of these hurdles is from 1000 to 1500 feet. Their cost ranges from $10 to $35 per lineal foot.

The original plan adopted for bank protection was to excavate, where necessary, a trench to the depth of 8 feet below lowest water, and fill it with brush in crossed courses, the tops reaching outward as far as practicable to form a mattress to protect the base from scour. On the brush, riprap is placed until it appears at mean low water, assumed 5 feet 6 inches above lowest low water where it formed the base of the stone revetted slope, with an inclination of 1 vertical to 2 horizontal. This work has served its purpose well and is still in good condition, probably owing its stability to the fact that it was placed in comparatively shallow water. From 1875 to 1881, protection under water, or subaqueous protection, was given by rafts or mattresses of brush from 40 to 70 feet wide. These mattresses were effective except in deep water with strong current where their outstream edge was undermined.

In 1881 was adopted the form which, with modifications as to details, has remained in use until recently. It consists of a woven mattress of cotton wood, or preferably, willow brush. It has but one thickness of brush woven upon poles, is thin and flexible and sufficient strength during construction is secured by ample fastenings of nails, spikes, wire and cable, all of iron. Their width must be sufficient to reach to the foot of the eroding slope and a standard width of 120 feet is adopted as ordinarily sufficient. They are, as a rule, made continuous for each locality, lengths of from 5000 to 10,000 feet having been made and sunk. They are sunk and held in place by stone, and furnish permanent protection to underwater slopes, the few known failures having been due to the undercutting of the water which subsequently deepened. The average cost of brush mattresses 125 feet wide is $6.00 per lineal foot.

During the past four years a number of lumber mattresses have been built. The lumber used is the commonest culls 4 to 6 inches wide, 1 inch thick, and not less than 12 feet long. The mattress is formed by weaving the plank over and under plank laid longitudinally about 3 feet 9 inches between centers, like large split basket work. These mattresses require much less bulk of timber and of stone than the brush mattresses, can be built about twice as fast and cost only about $3.75 per lineal foot. Their only disadvantage so far as known consists in their breaking up worse when piles are driven through them.

Protection above water is given by grading the bank to its natural slope and covering with riprap. The paving is usually done as far as the river has graded its own bank and resumed the following season after the high water has extended the grade further up the bank. When necessary to grade the bank by artificial means it is done by the hydraulic method or by means of shovels, etc.

In addition to the permanent works of improvement, each year a certain amount of work is done to afford temporary relief to navigation or to hasten the results of the regulation works. The devices employed for this purpose include dredging and the use of temporary jetties to produce scour. The plant includes three suction dredges, a jet dredge, a tow and dredge boat, two other tow boats arranged to use their wheels in washing channels through bars and panels for about 10,000 feet of portable jetty. Several types of portable jetties or temporary dikes have been used. The type most favored is constructed by driving a row of

piles along the line selected and connecting them by a stringer which serves as a support for the upper ends of corrugated sheet steel panels, whose lower end rests on the bottom of the river.

Each panel is 10 feet wide and from 10 to 20 feet long, depending on the depth where it is to be used. To prevent scour taking place under the panels, a small fascine mattress 8 to 10 feet wide is fastened to the lower edge of the panel and sunk with riprap. At the end of the low water season the panels and piles are taken up and preserved for future work.

UPON THE USE OF

ELECTRIC SEARCH-LIGHTS

IN WAR.

(Revue du Génie Militaire, Nov. and Dec. 1901, A. Bochet, Reserve du Genie).

A free and incomplete translation by W. V. Judson, Captain, Corps of Engineers, U. S. A., Instructor, Engineer School of Application, U. S. Army.

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ERRATA.

P. 1, line 8, for "movable" substitute "suitable".

P. 1, line 12, for "the Boers" substitute "de Beers".

P. 2, line 15, for "abjective" substitute "objective".

P. 3, last line, insert decimal point between 2 and 7, to read "12.7 inches".

P. 6, line 23, after "engine" insert "plant".

P. 7, line 6, for "at least" substitute "about".

P. 8, line 29, for "is often" substitute "would often be".

P. 9, line 12, omit "practical".

P. 11, line 18, for "least" substitute "lest".

A FEW REMARKS BY THE TRANSLATOR.

We can not yet find in print the final opinions of competent critics upon the usefulness of the search-light as so extensively employed in South Africa, but many isolated bits of information indicate that search-light outfits will hereafter be recognized as indispensable adjuncts to warfare upon the land.

With ordinary Morse signals, directing a beam upon the lower edge of a movable cloud, the British sent messages regularly to Ladysmith, 30 miles distant, until the Boers succeeded in confusing the signals with their own apparatus.

At Kimberly, three search-lights, which had been used by the Boers to prevent thefts at night from the mines, were mounted in commanding positions along the line of detached works erected for the defense of the town. It was not doubted by the besieged that they constituted a great protection and probably prevented a night assault. Ladysmith and Mafeking were without search-lights and assaults were delivered against each of them.

There has been a very extensive use of search-lights in connection with the lines of blockhouses and upon armored trains.

There can be no doubt of the disconcerting effect of the search-light upon outposts and patrols, who suddenly find themselves blinded by the beam of light and exposed to the enemy as illuminated targets.

The importance of night attack has been gradually increasing, enabling troops to effect a surprise, or to pass over a fire-swept zone that would be practically impassible by day. Search-lights, in the hands of the defense, might easily frustrate such operations. It is conceivable, moreover, that search-lights might be most valuable adjuncts to the attacking party at night. When the tactical use of the beam has been worked out, we may find, for example, that if several parallel beams be directed against the enemy's lines, columns may advance in the dark intervals, with their objective illuminated, their enemy blinded, and their paths marked by the visible beams upon either side. The translated article which follows is interesting mainly as showing the character of outfits adopted by the French—who might be expected to lead in such matters—for coast defense, fortress and field use. The French use principally the 1.5 meter projector for coast defense, and it appears that such a projector gives an intensity of illumination at any distance between 3 and 5 kilometers, three times as great as does the .9 meter projector, the latter being about the largest employed in U. S. coast defense. It will be observed also that the French prefer the oil engine. For field use it would seem that the oil engine is indispensable.

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POWER OF PROJECTORS.

The power of a projector depends upon the brilliancy of the source of light and the surface of the reflector; with a constant source of light, the "practical illumination" is proportional to the area of the mirror surface as projected upon a plane perpendicular to the axis of the latter.

The following table shows intensities of illumination obtained with Mangin projectors of .90 m. and 1.50 m., respectively, at distances varying from 3 to 5 kilometers. This table assumes a transparancy of atmosphere corresponding to the average in France for six months of the year. The intensities of illumination are indicated in "lux," one lux being the illumination produced by a standard candle, placed at a distance of 12.7 inches.

INTENSITIES OF ILLUMINATION OBTAINED WITH MANGIN PROJECTORS.

Dimensions of the apparatus.	Distance.	Total diameter of the beam.	Diameter of the central shaft.	Total co-efficient of transparency.	Degree of illumination, in lux.
Projector .90 m. in diameter; current of 100 amperes; focal distance .45 m.	M.	M.	M.		
	3000	106	80	.78	7.75
	4000	142	107	.72	4.92
	5000	177	133	.66	2.35
Projector 1.50 m. in diameter; current of 180, ~~100~~ amperes; focal distance .75 m.	3000	92	69	.72	21.4
	4000	122	92	.72	11.1
	5000	153	115	.66	6.54

For purposes of comparison it may be remarked that the light of the full moon, at the zenith, and under the most favorable conditions, corresponds to .20 lux. The brilliancy of the projectors at the distances indicated above is then of great intensity.

The really useful range is, however, that at which the observer can clearly distinguish the target. It then depends alike upon the power of the projector, the distance between the target and the observer, and the means of observation employed by the latter. It is very evident that the observer should be as near the target as possible, but it is also necessary that he use a good night glass which increases considerably the real value of the projector.

The following table shows the practicable ranges for clear weather:

Diameter of Projector.	Ships of small tonnage.	Large ships.
1.50 M.	3400 M.	5400 M.
.90 M.	2699 M.	4000 M.
.60 M.	2100 M.	3500 M.

It is not at all necessary to consider the figures tabulated above as absolute measures of capacity, analogous to those of pieces of ordnance. They give simple indications as to the chances of visibility of the targets.

USE OF SEARCH-LIGHTS AT SEA.

Since their first appearance the Navy has possessed search-lights. Their use afloat has developed very rapidly and to-day every war vessel is equipped with suitable apparatus. The different navies have lately acquired great experience in the use of search-lights and know how to make the most of them.

At present there are two established types of naval apparatus. One, the *mast* search-light, is placed in the fighting top or upon some high part of the ship, in order to have as extended a range as possible; the other, the embrasure search-light, on the contrary, is placed in a low part of the ship in order to light the surface of the sea close at hand. Generally an armored war vessel carries 2 mast lights and 4 embrasure lights.

COAST DEFENSE.

Projectors used for coast defense are of the following diameters:

.60 m., .90 m., 1.20 m., 1.50 m.

So great an advantage pertains to the projectors of largest diameter that the present tendency is to use, principally, the 1.50 m. search-light for coast defense. For this service the different projectors employed are subdivided, according to their use, into searching lights, fighting lights and fixed lights.

The first are used for sweeping the sea, to search for and discover hostile vessels. When one of these lights finds a ship it follows it until the vessel enters the zone lighted by a fighting light. The searching light is now free for new observations. The fighting light assumes the lighting of the target in the zone assigned to it, rendering effective the fire of the corresponding batteries. In its movements, the target passes from zone to zone, always lighted by the fighting light pertaining to the batteries in action at a given time.

The system is completed by the fixed lights commanding the lines of torpedoes barring the channels.

The searching lights and the fighting lights are electrically controlled from a distance. The fixed lights are pointed by hand once for all.

A SEARCH-LIGHT INSTALLATION INCLUDES:

(1). The *fighting station* where the search-light is installed during its action.
(2). The *station of command*, whence the light is electrically controlled and the observations taken.
(3). The building enclosing the dynamo and the different accessories.
(4). The *shelter station* where the projector is placed when not in use.

APPARATUS FOR PRODUCING THE CURRENT.

In examining the conditions which surround search-light installations during engagements, we see the importance of giving them perfect autonomy in order to render the service surer and easier and to limit the vulnerability.

The installation should be designed for but a limited personnel, and the latter should be sheltered as much as possible. The plant should be complete in itself, for in action it will often be very difficult to reach it. In fact, no

important repairs could be made at such a time; it is then essential in order to insure continuity of action at a station, that the apparatus employed should be as little as possible subjected to damage, and in every case that repairs should be made rapidly by means of material held in reserve.

The electric current for search-lights is produced by a compound-wound constant-potential dynamo, which is actuated by a constant speed engine supplied with a governor. In the beginning only steam engines were used. Many stations have been fitted up with "Brotherhood" engines directly connected with the dynamos. The same are also used in portable outfits, running with free escapement or with condensation. Since oil engines have come into use, however, preference has been accorded them. This preference is perfectly justified by the following considerations:

The oil engine plant is simpler than the steam plant, the latter requiring bulky fuel, boilers, etc. The operation of an oil engine is much less troublesome, for the fuel is supplied automatically, while the steam plant requires attendance to keep up the fire as well as to regulate the water supply. The oil engine, unlike the steam, works without producing escapements of steam and smoke, very visible at a distance, which may interfere with the beam of light. This last inconvenience is one of extreme gravity, for when the wind blows the smoke in the direction of the beam, it is absolutely impossible to use a steam plant.

With a system which provides for cooling the water of circulation in an oil engine, the latter can run indefinitely without any expenditure of water, or it can use sea water without inconvenience of any kind. The steam engine, on the other hand, consumes a quantity of fresh water, or is forced to employ a complicated system of condensing; and experience proves that it is very difficult to keep fresh water stored for coast defense search-light plants. Moreover, the preservation of the boilers in stations little used is almost impossible. In a short while the boilers become unfit for use. The maintenance and preservation of an oil engine are on the contrary, very easy.

Nevertheless, the use of the oil engine being less extensive than that of steam plants, it is more difficult to find capable mechanics to use the former than the latter. But as search-light plants necessarily contain many special pieces of mechanism we can not dream of obtaining good results except by providing special personnel. It is thus that the Navy has succeeded in assuring the perfect working of their fixed defense stations. The instruction of an especial personnel is not more difficult for oil than for steam plants.

We shall take it for granted then, that modern outfits include oil engines. Naptha motors have been excluded on account of the danger from that liquid and because of the great difficulty of procuring supplies of it.

FIGHTING STATION.

The station "de combat" is placed so as to have an extensive view of the zone of battle. To facilitate surveillance of the sea it is better not to place the projector too high, in order that the beam, sweeping the water surface, can discover the targets by a simple horizontal movement. It is necessary, nevertheless, to place the light where it is sheltered from the waves and spray of the sea. One generally tries to place the apparatus at least 15 m. above the sea level, but that height is not fixed and depends upon local circumstances.

THE STATION OF COMMAND.

The station of command should naturally afford as extensive a view as the fighting station, so that the observer can follow the beam in all its movements. As the beam revolves in a horizontal plane it is necessary to choose the position of the command station so that the normal distance between the observer and the beam should be convenient for the principal direction of observation. Practically, an effort should be made to put the command station at a distance of at least 50 m. from the fighting station and it would be better to have the distance from 60 to 100 m., measured on a line perpendicular to the beam in its most useful position.

In order to determine the altitude of a fighting station, and of an observation station, it should be remembered that the point of tangency upon the sea of a ray of light, bent by atmospheric refraction, and issuing from a point in altitude H (in meters), is at a distance D (in kilometers):

$$D=4\sqrt{H}$$

If the target under observation extends h meters in height above the sea, the distance at which the highest part of the target is visible to an observer at an altitude in meters H is, then,

$$D=4\left(\sqrt{H}+\sqrt{h}\right)$$

POWER HOUSE.

The sheds built for sheltering the machines should be of dimensions corresponding to the type of plant used. For a plant embracing an oil engine and direct connected dynamo, good results are obtained if the shed be 5.50 m. in length, 4.50 m. in width and 3.50 m. in height.

STORAGE FOR OIL.

In the neighborhood of the plant there should be a magazine for the oil, containing a reserve of about 8000 litres. For the security and preservation of this supply, the oil should be placed in metallic receptacles, perfectly free

from leaks, completely full, well-closed, and stored in a shed of which the temperature should be kept as constant as possible, and not above 35° C.; it should be possible each year to verify, barrel by barrel, the state of the oil supply. The magazine should be make of incombustible material, insulating the oil from the sun's heat. The facilities for inspecting the vessels should be as effective as possible.

In order to obtain these results secure the following conditions:

(1). Storage in metallic barrels, each of 100 litres capacity.

(2). Complete control of the oil supply by the personnel of the station, requiring no handling of barrels for supplying the engine.

(3). Facilities for examining the receptacles in order to control leakage.

(4). The possibility of gauging any barrel.

(5). The possibility of using the barrels in such order that if the beginning of deterioration in some barrels is ascertained, their contents can at once be used in the course of drills.

(6). The possibility of taking out and replacing any barrel whatever without having to displace other barrels.

To secure these conditions follow the arrangement (represented in a figure). This magazine, which is but 5.50 m. long, 3.60 m. wide and 2 m. high, can hold 8000 litres of oil in 100 litre barrels. These barrels are placed in two tiers, held up by metal beams, so that it can at once be seen if any barrel begins to leak.

SHELTER STATION.

The shelter station of a projector is a room where the projector is placed when not in use. This room should have dimensions equal to those of the fighting station.

FORTRESSES.

For the surveillance of certain terrain near a fort, such as roads, canals, railroads, etc., fixed search-light stations are employed. The arrangements are the same as for projectors used in coast defenses. But in order to insure a perfect surveillance of the approaches to a place, it is often necessary to install a considerable number of fixed projectors, and it is frequently practicable to recur to the use of movable apparatus. Ordinary field apparatus is well suited to operations of this kind.

MATERIALS FOR THE FIELD.

Until recently, projectors have not been used practically for service in the field because the apparatus could not be run except by steam machines. Portable steam engines, boilers and dynamos, notwithstanding important improvements, have presented hopeless defects for use in field

operations. Such plants use such a quantity of coal and water that it is practically impossible to secure their supply in the field. In fact, the models used so far, which have a current of only 50 to 60 amperes at 70 volts, consume a total weight of coal and water varying from 300 to 400 kgs. per hour, and so would use from 3 to 4 tons during ten hours of night service.

It is not possible to have such an amount of provisioning follow the outfits without robbing them of necessary mobility. In fact it is often necessary to transport the apparatus quickly during the night, for a long distance, to establish it upon some high point whence the best results can be obtained.

To insure the work of a projector, if steam power were employed with a whole train of heavily loaded wagons, would be much too difficult for actual service. The practical use of portable oil engine outfits provided with apparatus for cooling the cylinders, obviates all these inconveniences. Experience has proved, in fact, that the necessary supplies for a portable oil outfit weigh but one hundredth part as much as for a steam outfit of equal power; moreover, the oil engine, being fed with a liquid from a reservoir directly connected with the cylinder, does not require any stoking in the field. With this system it is easy to devise a plant for the production of electricity, provided with all necessary accessories, carrying sufficient provision to insure its running for several nights, and easy to move, all being mounted upon a single vehicle.

The outfit is completed by a projector mounted upon a two-wheeled carriage attached to a limber, the latter carrying cables and other accessories. Thus two vehicles suffice for a search-light equipment.

FIELD ORGANIZATION.

As a result of observations made in the field by the author, who has had occasion many times to use the projectors at manœuvres, it would seem that this apparatus should be used as follows:

To be really efficacious the projectors should be placed upon the most advanced lines. It is not necessary, as has been thought until now, that they should follow the artillery, whose position is much too far to the rear, especially at night, for projectors placed near them to illuminate the enemy successfully. If stationed with the advance posts, they make it possible to reduce materially the number of troops detailed there for night service, by insuring a perfect surveillance of the ground in advance.

Personnel.

The equipment should be under the command of an officer, who would himself act as observer. The personnel should include two mounted men,

one of whom, an under officer and mechanic-electrician, should attend the generating plant, and the other, an electrician, should have charge of the projector, its lamp and accessories. There should be, in addition, at least two assistants. To this personnel should be added the signal men, signals being necessary in the first place to establish communication between the projector and the observer, where facilities are lacking for electrical control at a distance, and in the second place to put the observer in communication with the command and the groups with whom he is to coöperate. These communications naturally require a man at each post; the telephone or optical telegraph is used as may be most convenient.

MARCHES.

Movements of the apparatus should always be as rapid as possible; they are made principally over well defined roads. Night marches at a quick pace are particularly precarious for them. Each day, before nightfall, the carriages should be carefully inspected, and the packing of materials well attended to; before departing, the draught harness should be minutely inspected, in fact it is well to move the carriages back and forth a few paces. It is essential to use none but driver and horses accustomed to night marches. Special training is necessary so that men and horses shall completely respond to the exigencies of the service. The column should be preceded by a mounted man, marching 5 or 6 m. in advance of the team of the first carriage; this man should verify the road, and set the pace for the column. First should come the carriage of the projector, then the wagon bearing the generating set. A mounted man should follow the column to see that nothing falls from the wagons. When out of hostile view each carriage should be supplied with two powerful lanterns fashioned so they can be masked if the equipment should wish to conceal its march. The men not mounted will ride upon the carriages.

ESTABLISHMENT AND PREPARATION OF THE APPARATUS AT ITS STATION.

The outfit should be ready to act on arrival upon the field; there should be no overhauling of the apparatus at this time. The carbons should be in the projector, and the preparatory operations will consist of starting the motor, and running the cable from lamp to dynamo, and to the station of electrical control if necessary. These preparations should be made in a few minutes, 6 or 8 at most; the projector will rest upon its carriage except under extraordinary circumstances.

DIRECTION OF THE BEAM OF LIGHT.

Two cases present themselves. Observations will be taken either by the squad itself or by observers independent of that party and nearer the objective than it is. In the first case the principal objective will generally be designated by a system of coördinates.

Unless entirely impossible, a preliminary reconnoissance by day of the principal objectives and the neighboring country should be made by the officer in charge of the squad, with a view to choosing the most convenient places for the generating set (power wagon), the projector and the observer.

The power wagon should be sheltered as much as possible, and should be easy of access; the location of the projector should be such that the beam can be directed upon the objective without encountering an obstacle. The observation station should be chosen to afford the best possible view of the objective. The beam should be directed from the observation station either by means of the apparatus for control at a distance, or by directions transmitted by telephone or optical signals to the man charged with the pointing of the projector.

In every case, before lighting the lamp, care should be taken to turn the projector in the direction of the target, and to incline it upward, least it illuminate the ground near the projector, and expose to view its own lines. At the time of lighting, the projector should be hidden by a screen from view of the enemy; the apparatus once in regular working order, it should be unmasked and the beam gradually lowered and traversed in a lateral direction so as to search the ground until the objective is found.

OBSERVATION.

The intelligent observation of ground illuminated by the projector requires a certain skill. The observer operating for the first time finds himself all at sea. He sees nothing clearly. When he begins to distinguish objects, he commits gross errors as to distances, and generally experiences a keen disappointment at not being able to perceive certain details, without realizing that they would not be visible even in broad daylight. Exercise quickly accustoms the eye to observations of this kind, and trained observers attain remarkable results. The observer should be provided with good glasses, having objectives of as large diameter as possible, but of small magnifying capacity, and with no diaphragm, in order that none of the rays received shall be lost. It is necessary to take exact account of the general form and color of the ground in the neighborhood of the target, in order to select landmarks that will enable one readily to pick up the target a second time; light

colored surfaces serve well as landmarks; houses, quarries etc., are easily found again in the rapid movements of the beam over the ground under surveillance.

It is generally unnecessary to attribute any serious value to immovable objects of a dark color. Often they are but well marked shadows, produced by natural objects. It is often advisable to send an observer to a point some distance removed from the regular observation station.

In every case an essential condition to success will be a perfect coöperation between the personnel of the search-light squad, and the troops placed in front. For example, when a squad is working behind the outposts, observations should be regulated according to the position and movements of the latter, and a single commander should control the movements of both.

TRANSMISSION AND REGISTRATION OF OBSERVATIONS.

In order that the projectors should be of maximum service, it is essential that the observations taken should at once be transmitted to the commander and to the troops interested. The observers should record the time at which observations are taken.

For transmission of results to the troop commander, telephones, ordinary signal methods, telegraph or written reports may be employed. Records of observations should be made by a non-commissioned officer or private, under the directions of the observer, and furnished with a special lantern.

Attention should be called to the utility of the power plant even out of battle, thanks to the facility with which it can supply current for arc or incandescent lights, and for motors to actuate cranes, hoisting engines etc.

MILITARY

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make larger

By M. LEFEBVRE.

Translated from the "Journal des Sciences Militaires,"

September and October, 1901,

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MILITARY LANDSCAPE SKETCHING.

THE USE OF LANDSCAPE SKETCHING IN THE FIELD AND IN RECONNAISSANCE.

INTRODUCTION.

FAR from being a complete treatise on military sketching this work is but a collection of practical hints addressed to officers who love and cultivate landscape sketching, to the end that they may exercise their talents in that art with profit to their military education, and during reconnaissance produce useful documents relating to the field that they have gone over and studied.

Military Uses of Drawing. Perspective drawing often supplies a needed complement to the related art of topographic drawing, and occasions arise where perspective drawing is to be preferred. Used properly, with a few strokes of the pencil it reveals the horizon and gives a silhouette of prominent parts of the landscape. Separating by a rapid drawing that which is essential from that which is insignificant, it is, beyond doubt, the simplest and cleanest expression of that which the eye has seen and analyzed. This is what de Brack thinks of it: "It is as necessary for an officer to know how to draw as to know how to write, for often with two lines he can tell more and tell it better than with two pages of writing, inasmuch as a few strokes of the pencil are made more quickly and easily than a report is composed, and secure and classify details for a report much better than do the memoirs which we preserve from a long reconnaissance."

But aside from this direct usefulness, there is another equally to be considered. Drawing is the educator of the eye, *par excellence;* it teaches one to judge ground rapidly by developing that instinct which gives to the sight power and certainty not acquired otherwise than by the habit of studying the landscape in detail and in its various aspects. Finally it engenders an accuracy of observation which mechanically notes the form and aspect of things, even though the mind be occupied with other matters. On this subject also we quote de Brack: "Drawing has an immense advantage in war; it accustoms one to look and to observe well, to appreciate distances and the character of the ground, to bring to mind that which one has seen, and above all to judge of the expediency and probable rapidity of execution of a projected enterprise".

"The habit of sketching gives to the memory a faculty that might be called instinctive, that of grasping, so to speak, in spite of ~~yourself~~ yourself, and in spite of mental distraction, the form and color of ~~the~~ objects ~~before you.~~ near."

This last quotation is but a clipping from the detailed account of a reconnaissance which seems to have been made by the eminent author himself, if one may judge by the precision of detail and the freshness of impression. This vivid narration, full of examples taken from fact, shows what value this master of the art of reconnaissance attached to the gift of observing well. One may consider it the most perfect expression of that which our regulations, perhaps too abstractly, call "knowledge and use of terrain".

Here are other and contemporary opinions upon the military use of drawing: "A map, however accurate it may be, leaves us always face to face with an embarrassing abstraction, failing to indicate the relief of objects, houses, trees, etc. The contours and even the hatchings leave the model unsatisfying. For everyone picturesque views taken of happily chosen places must facilitate the reading of ~~charts~~ maps by reproducing nature in familiar aspects".* "Perspective study is the necessary complement to topographical study; I will even say that it is sometimes more important than the latter for the study of configuration; that is to say, for the passage from map to nature in a country seen for the first time, where one makes an armed reconnaissance".†

Is Not Photography Preferable to a Sketch Made by

*Jouart.

†Panoramie Militaire.

Hand? This question is not asked to-day for the first time; it may be said to date from the birth of photography, from which time geographical science began at once to draw every advantage possible from the discovery.

We speak here but from memory of the attempted substitution of photography for landscape sketching (the devices of Laussedat, of Dubroni and Chevalier, and finally the Moessard cylindrograph, which seems to be the last gasp of topo-photographic art). Results with such apparatus have been very good, but their use seems more allied to topographical than to landscape sketching, and they are thought to be especially adapted for use in exact and regular work, notably during a siege. Returning to the main question—the use of photography in field reconnoissance in the presence of the enemy, sometimes even under fire—it is but just to admit that to-day portable instruments are made remarkably perfect, of but small weight and bulk, easily handled, and under certain atmospheric conditions capable of producing very clear and satisfactory plates. But the light is capricious, now more and now less propitious for good work. It often happens that certain useless details are brought out very clearly, while others, more essential, are scarcely perceptible. Let us add finally that the landscape does not lend itself readily to photography except under certain picturesque conditions which are not always present in important tactical situations. What must we then conclude? That whenever conditions are favorable to the use of photography, we should have recourse to it, profiting by its convenient and rapid methods to increase the number of views taken at different points, thus rendering more complete the study of the ground. On the contrary, if there is reason to doubt photographic results with distant and unaccentuated objects, or if trouble arise with the light or for any other material cause, it is to rapid free-hand drawing that we must resort.

After all, instead of seeing between these two processes an antagonistic striving for supremacy, it is more rational to look upon them as valuable aids to be used at need concurrently, one to be called upon to supplement the other according to circumstances and to the special applicability of each. Photography gives brutal exactitude to nearby objects; illusion falls to the ground. Sketching, on the other hand—more abstract, more adaptable to the translation of thought as well as of form—permits the military details of a site to be more clearly brought out.

The progress of photography should not then discourage an officer from landscape sketching, nor make him doubt the resources of his art, which depend entirely upon his observation and his apprehension. Moreover a good landscape artist should easily become a photographer of merit, while the converse does not follow.

PART I.

ON MILITARY SKETCHING. GENERAL EXPOSITION OF THE METHOD.

One should not think of entering upon military sketching without having previously acquired knowledge of the general principles of drawing, including the elements of perspective, which are its foundation. This knowledge naturally much simplifies the task; sketching from nature affords the best training for appreciation of varying aspects of the ground.

Special Characteristics of Military Landscape Sketching. Although nothing other than landscape sketching, military sketching possesses certain peculiar characteristics inherent to its aim and object. It is thus indispensable, no matter how good a sketcher one may be in the ordinary acceptation of the term, to have a special training, and so learn to overcome, one by one, the small difficulties, generally unexpected, that arise in practice every moment, and become very troublesome if one is not sure of a firm and rapid execution. In purely artistic drawing the laws of æsthetics and of harmony, the search for effect and for the picturesque, are primary; in military drawing these charming qualities become absolutely secondary; its sole charm, its sole claim to perfection lies in its clearness and in the facility of its comprehension.

Accuracy, firmness, freedom and simplicity of stroke, a correct generalization of the background—these should be sought above all. In short, even if the æsthetics of ordinary landscape drawing would seem thus to be violated, for military purposes one may

draw upon topographical drawing, representing objects by certain conventions, in order to effect greater clearness and facility of execution. But one should not alter the nature of, or untruthfully interpret the silhouettes marking the terrain, for these are the most essential elements of a reconnaissance drawing.

Is Mathematical Perspective Indispensable to Military Landscape Drawing? In his interesting work on military sketching, Captain P. H. C—— sets forth a method of mathematical perspective based upon horizontal scales and apparent heights, which he recommends as facilitating deductions as to distances on the stadia principle. It is beyond all doubt that mathematical perspective is excellent practice, teaching the eye to appreciate distances and proportions. One can even imagine its being practically employed in a drawing made in all leisure and security. But the conditions are different in the field during a reconnaissance. On such occasion it is necessary to act with quickness and resolution. For an experienced eye and sure hand, the figure and the perspective outline established methodically would be more awkward than useful. One hesitates and gropes, and finally the time has passed, and the essential parts of the drawing are still incomplete. This would not have happened if eye and hand had acted instinctively, as the result of previous practice.

One should not exact from drawings more than their nature permits them to show. They readily reproduce outlines and general forms, the visible horizon, etc., but it would be extravagant to hope to deduce from them correct estimates of distances, for a mathematical perspective, no matter how well shown it may be, always leaves doubt when the data has not been obtained from surveys.

Method to be Pursued in Military Landscape Sketching. Whether in the simple sketch of a position, or in the reproduction of a vast and extended view, military sketching is but the development of a panorama, through a visual angle more or less great, according to the object and purpose of the sketch. Before coming to the drawing, however simple it may be, in order to fix one's ideas, and establish his style, it is necessary to engage in some preparatory exercises designed to teach one to avoid a halting execution—an inexcusable fault. Without mentioning *esprit*, which naturally plays a great part in the art which occupies us by its qualities of conception, of fitness, of discernment, the military sketches should, above all, educate and train the two physical essentials, i. e., the eye and the hand.

As to the hand it should be exercised:

1st. In the representation of foreground, background and middle distance by means of their outlines (silhouettes);

2nd. In the representation of form of ground by means of hachures and perspective curves.

As to the eye, it should be trained:

1st. To an understanding of the lines and angles;

2nd. To observation and to the reading of ground.

We propose to treat of these different exercises separately, explaining what they mean and how they may be practiced. Afterwards we shall describe in detail the execution of a military landscape sketch.

Finally we shall deal with tactical application of landscape sketching as used in reconnaissance.

PART II.

PRELIMINARY EXERCISES.

TRAINING OF THE HAND.

The Silhouette. It is necessary to indicate by lines, and as far as possible by single strokes, the appearance of different objects on the earth's surface, producing a sort of aerial perspective, sufficient to give an idea of distance, thus facilitating the clearness of the sketch. Inasmuch as the stroke can not be shaded, except by increasing its vigor and intensity, it is necessarily upon that idea that a scale of distances must be based.

Scale of distances.—The general rule is as follows:

Foreground,—Vigorous stroke, made by pressing firmly upon the pencil.

Middle distances,—Mean stroke, made by pressing normally.

Background,—Fine stroke, made by pressing lightly.

In the majority of cases this rule will suffice to give to a sketch atmosphere and a perspective easy to grasp without the use of shading, which should be avoided in rapid work, because it represents loss of time and usually smirches the sketch, thus depriving it of clearness. In order to fix the ideas and establish a standard intensity of stroke, one should regard as in the foreground objects distant from 300 to 500 meters; the middle distance may extend from 500 to 1000 meters, and the background includes objects distant more than 1000 meters. Such a gradation has the advantage of approaching that established for infantry fire (short, long and medium ranges); it is a coincidence which will be very useful in a number of cases.

Pencils and Paper. The lead pencil is undoubtedly best for the execution of rapid sketches. If one has different numbers, the gradations of distance will be more easily realized; in any case for the background, the point of the pencil must be kept sharp. As for paper, it must be smooth for a flowing stroke, and if possible divided into squares, especially at the start. The squares guide the strokes without encumbering the drawing, if one is careful to choose for them color different from that of the pencil.

REPRESENTATION OF DETAILS.

Buildings (houses, farms, chateaux, villages, etc., see fig. 1). Indicate simply their silhouettes, avoiding even in the foreground unimportant details. In most cases it is best to begin the drawing of an edifice with its most prominent points (roofs, gables, etc.), which are generally more visible—more readily seized by the eye—and which give at once an idea of the orientation of the building. Above all, draw carefully the contour of buildings which may serve as reference points (towers, windmills, lighthouses, factory chimneys, etc.). In the drawing of walls, which nearly always have a military importance, one must as nearly as possible show by the perspective their orientation and their changes of direction.

Do not exaggerate the height of buildings, for the resulting error is carried back horizontally and absolutely perverts the idea of distances.

The indication of details should always be governed by distances. If, for example, in the foreground one is able to show some doors and windows by means of hatchings, in the middle distance one is content to indicate them by strokes, while in the background a general idea of the roofs and bodies of buildings will suffice, always selecting prominent buildings, easily recognizable.

In sketching proceed with elementary strokes, not trying to join them invariably at the angles; the drawing thereby gains in freshness and in facility of execution.

Routes of Communication. (See fig. 2.) Indicate them by two perspective lines, representing the borders of the road. When the road is sloping that fact is indicated by the degree of separation of the lines; above all draw with distinctness curves indicating changes of direction. Paths and minor roads will be indicated as in topography, by dotted lines of lighter texture than are used for main roads, and with less separation.

Various artificial objects are represented by their essential parts (arches, abutments, etc.) Excavations and embankments will be shown by hatchings in accordance with topographical conventions. Railways should be distinguished by cross lines; a telegraph line by posts drawn at intervals.

Trees. (See fig. 3.) Show merely the general outline and the trunk by lines more or less strong according to the distance Above all reproduce faithfully the silhouettes of isolated trees that may serve as reference marks. In the drawing of trees, it is well to recall as a general principle that between a tree and its leaf there generally exists in structure and form a great analogy.

Woods and Forests. (See figs. 4 and 5.) With a light dotted line rapidly fix the outline of the wood with its salients, and in the area thus inclosed draw the trees more or less apart according to the thickness of the wood, with a strength of line and relative size dependent upon the distance; for greater facility sketch first the salients and conclude by filling in the interior.

Without aiming at a perfect resemblance it is nevertheless necessary to bring out the clearings, the characteristic clumps, easy to recognize, and the lanes indicating roads

When a forest or wood possesses great depth, it is advantageous to outline not only its border, but also lines of demarcation between the different distances (foreground, middle distance and background) to guide the intensity of the stroke.

Pine and spruce are of a dark green hue and stand out boldly over all other foliage; for these two species a special treatment is recommended, and strong lines must be used. When these trees are scattered in clumps in a forest, they should be rendered very exactly, both as to form and place, for they catch the eye at once and are very useful for orientation.

Copses and Waste Land. Outline as for a wood, with dotted line, the border of the copse, and place here and there some trees, filling in with brushwood more or less thickly, according to the growth. The waste land is rendered by a mixture of brushwood and sand as in topography.

Cultivated Land, Hedges, Orchards. (See fig. 6.) Indications of cultivation will not be used except when military interest demands in order to give an idea of shelter and of the practicability of the ground. When cultivation of one character is repeated to any great extent it is convenient to indicate the same by a conventional letter upon the sketch. Low growths

which interfere neither with the view nor with the practicability of the ground may be shown simply as open fields; furrows may be shown by a series of parallel hatchings, placed in different directions; vines, which should always be indicated as they are a serious obstacle to the march of the three arms of the service, may be shown by the letter V, if they are extensive, or if covering but a limited area, by a series of short hatchings graded in height according to the distance.

Orchards will be represented by regular rows of trees; hedges by a row of bushes of greater or less height.

Sand Dunes, Marshes. (See fig. 7.) These will be represented according to topographical rules

Rocks, Cliffs, Escarpments. (See fig. 8.) Try to render their silhouettes and their fissures very clearly; in drawing cliffs it is necessary to show as plainly as possible the general direction of their geological lines, which give them character and individuality; granite is angular and slashed (rounded and dull when exposed for a long time to the weather); limestone and sandstone generally break off at right angles; slate is ragged at the edges and in layers. To sum up, each rock has a form all its own, and this form should control the sketch.

Water. (Rivers, ponds, lakes, seas, etc., see fig. 9.) Indicate clearly with a firm, vigorous stroke, the border; then the reflection of some objects on the banks; then a series of horizontal markings more and more delicate toward the background. When there is a great stretch of water, suggest the light of the sky by showing here and there some reflections rendered by horizontal hatchings; finally the indications of some clouds will dispel all doubt.

In the preceding enumeration it is possible that we have forgotten some details; nevertheless the general principles are as set forth therein. It is necessary to confine oneself consistently to his adopted methods, reproducing the silhouettes clearly and neatly, and as simply as possible, leaving the object to be represented subject to no doubts.

Every country has character and aspect peculiar to itself and in consequence admits of an especial interpretation that is best adapted to represent its habitual forms.

Representation of the Formation of Ground by Curves and Perspective Hatchings. (See figs. 10 and 11.) For sketching the ground, stomping and rubbing are evidently the

quickest processes, and for that reason tempting; but these methods admit of little precision and clearness, and in rendering certain changes of slope, or the delicate details of relief, they become absolutely insufficient.

The following process, more precise and equally rapid, and speaking to the eye in the clearest fashion, seems preferable in every way; it consists (once the ridge lines are determined), in representing the undulations of the ground by means of strokes, or elementary lines, giving the sense of *perspective* to contours ~~curves~~ and topographical hatchings. It is well to say here that some of the theories observed in the artistic handling of landscapes have no place in such sketches as we are considering.

The reproduction in perspective of countless curves and topographical hatchings can evidently be conceived of, but practically such work overloads the sketch, and complicates its execution. One therefore confines himself to a few such lines perspectively oriented; they are amply sufficient to give a very clear and complete idea of the formation of the ground.

We must add that in the majority of cases other lines of the sketch. especially ploughed furrows, hedges and signs of cultivation will easily determine the direction of the strokes and aid in showing very clearly the relief of the ground.

When these indications are lacking, which will happen in regions bare and of uniform appearance (in mountainous countries, for example, or upon the plains), perception of slopes of the ground will be a very delicate matter, and the sketcher will have little but ridge and valley lines to guide him. He must then, in his imagination, draw contours upon the ground, and consider their appearance, in perspective, upon his sketch. Study of this kind is excellent, whether from the point of view of sketching or of topography.

One must also use discretion in knowing when to employ curves and when hatchings. On ground which one overlooks, curves are most conveniently used; on the contrary, when the ground lies above one, hatchings must be adopted as they convey the clearer impression. There is no positive rule in these cases; the best guide is unquestionably the nature of the ground, which by its appearance indicates the proper interpretation to select.

In a slightly undulating country, it is not rare to meet with certain depressions in the ground, more dangerous in that they are scarcely perceptible, and thus suggestive of ambuscade. These

are often large ditches, with gentle slopes, whence a body of the enemy may spring up unexpectedly and fire upon you point-blank. It is essential in every case of military sketching to mark such peculiarities of the ground by a method which will be described and which is applicable up to a distance of 500 or 600 meters, or as far as the silhouette of a man is plainly visible. (See figs. 12 and 13.)

Let us show the depression of the ground A B D as seen by an observer from the direction of O. The ridge line A will first be indicated. Three human silhouettes we shall suppose are placed at A H, B H, and D H. The visible part of the silhouette B H will tell the depth of the ditch, while a comparison of the apparent heights A H and D H will give an idea of its width.

TRAINING OF THE EYE.

The education of the eye, even more essential than that of the hand, depends entirely upon the habit of the observer; it is necessary to notice, to compare, to judge and to comprehend, which require long and continuous practice. But on the other hand the faculty of observation possesses this precious characteristic that, once developed, it is exercised instinctively, without distracting the mind from its chain of thought. Besides we shall find innumerable opportunities for exercising this faculty during a march, going to and returning from drill and ~~from~~ target practice, during halts, in brief on all occasions where the duty does not demand all one's attention.

Appreciation of Lines and Angles. Above all one should accustom himself to a just appreciation of lines and angles; this is the basis of all drawing. The courses in landscape painting and modelling offer many expedients very simple and easily used (as a pencil or graduated rule held before the eye with extended arm, serving to compare distances or apparent heights; a protractor, which may consist of a pair of improvised dividers. The length of the thumb at arm's length is also a useful means of comparison, and can be employed with almost mathematical precision if one is careful to note the value, once for all, of the visual angle to which it corresponds; that angle is approximately 3° 30′).

For a beginner in the art of sketching, to train his sense of proportion, such expedients are of undoubted value. But after training and constant practice the eye itself acquires a sense of proportion which is exercised without assistance from rudimentary devices such as above described.

Observation of Ground and Study of Terrain. To know how to value justly lines and angles is much, nevertheless it involves but a mechanical use of the power of observation, and one could and should exact more from that faculty. It should be intimately connected with the judgment, and with a habit of rendering an exact account of what one sees and of drawing conclusions therefrom; it is for this reason that military sketching becomes a special art and is a study of great value in preparation for reconnaissance work.

Here are a few examples of what may be called studies of terrain, in which close observation is important:

1st example (outskirts of a village, see fig. 14). I arrive before the village of X which spreads out before me at a distance of about 1200 meters; at first sight the border of the village seems to be a continuous straight line; I look more attentively. In certain groups of houses the buildings seem a little higher; they have, however, no more stories and they are similar in construction to the others. But if they appear to me larger, it is because they are nearer to me; consequently they must constitute salients or detached suburbs (information useful for attack or defense). Further observation seems to confirm this assumption. The supposed projection A seems to border upon the road on which I stand. ~~Elsewhere~~ From the supposed projection B there starts a double row of poplars which leads me to believe that there is another road in that locality. Now there is a natural law in the growth of villages, that the outskirts and projections are generally situated on the main roads entering the town.

2nd example (border of a forest, see figs. 15 and 16). I am now confronting a forest; at first the edge gives me the impression of a straight and continuous line; I examine it more closely. At A and at B I find a very sensible difference in the height of the trees; moreover the curtain of trees at A is of a much fainter shade than at B. A is then undoubtedly more distant than B and the latter forms a decided salient. From C to D the height of the trees appears less; does that mean a reentrant? No, for their verdure is of the same hue as at B or C; besides at C and at D I no longer see the trunks of the trees nor the somber arch of the forest; moreover road R, whose summit stands out light and clean cut, does not at all convey the idea that it enters the wood at R, but rather at D, where I see a marked opening. In fact all things lead me to believe that the forest does not recede,

but that the ground, gently rising, forms a ridge in front.

Let me continue my investigations. At F the height of the trees is again lower, but as their trunks and their coloring are less marked there may be assumed a reentrant here.

From H to I the gradual lessening of the apparent height of the growth leaves no doubt about the existence of the salient H.

Fully informed by these observations alone, I can make the topographical map of the ground shown in fig. 16.

3d example (an apparently level plain, see fig. 17). Before me is a plain divided into cultivated fields, seeming to present no unevenness of ground; at about 600 meters there extends a line which crosses every field. Is it simply a line of demarcation between different fields, or a road, or is it a crest revealing a slight depression of the ground? On both sides of this line the light is uniform, a fact which increases my perplexity. I examine the orientation of the furrows on both sides, and I find that they are broken at sharp angles, which is rare in the case of a simple boundary or a road. It appears then to be a crest, but some doubt exists. Following along the line to the right I perceive that it crosses a road, the perspective of which is also broken; toward the left the line traverses an orchard, where I can clearly distinguish the trunks of the nearer trees, but only the tops of those more distant. There remains no uncertainty. It is a crest that is before me.

This problem of scarcely visible crests is sometimes even more difficult to solve, and in certain regions well-nigh impossible.

With these examples it is easy to understand what profit a soldier draws from close observation of ground, which is so changeable in appearance, and so varied in different parts of the country. Nature, always generous and inspiring in her teachings, is the educator *par excellence*. To the artist she reveals beauty, harmony, grandeur of form; to the soldier she will give quickness of eye, firmness of judgment and accuracy of decision.

Let me quote de Brack on this subject: "In order to progress in the art of quick and comprehensive observation, one's imagination must be constantly alert in war, at the hunt, in ~~our~~ movements afoot and on horseback".

PART III.

THEORETICAL AND PRACTICAL EXECUTION OF A LANDSCAPE SKETCH.

We will now proceed to the execution of a landscape sketch, assuming (which will not always be the case in the field) that we are operating in all safety, and without being limited as to time. But service conditions must always be kept in mind, in order to understand the difficulties to be overcome, to enable one to discuss them with himself, and to grasp clearly the different phases of the work.

It is proposed as a study and as a first effort to sketch the landscape shown in fig. 21.

PRELIMINARY CONSIDERATIONS.

Examination of Ground. It is invariably by this that one must begin. In many cases, it will even be useful to sketch, by guess, a rough topographical draft (croquis) of what one perceives. This sketch, despite its great inaccuracies, will at least have the advantage of fixing one's ideas and of affording an analysis of the ground observed. Let us add that this will often be the only record that one can secure in the course of a reconnaissance, which is an excellent reason for frequent training in it (fig. 18).

We march toward the north by the road AA′, and arriving at A, which is the summit of a ridge of average elevation, the position is disclosed.

We perceive:

In the foreground the declivities of the ridge upon which we

find ourselves; to the north they sink into a ravine which seems rather deep; toward the west they slope off and die away in a very open valley.

In the middle distance spreads out a second ridge, the northeast extremity of which partially hides from us the village B, of which we perceive, however, the bell tower. Halfway down its southern slope is the castle C and its park; then several farms; more to the ~~east~~ west are the village E, the park F, and the river H, of average importance, which is crossed by a stone bridge having three arches.

In the background extends a third ridge surmounted by a copse K, of which one discovers very clearly the outskirts; more to the ~~east~~ west is a table-land, rising gradually, with several farms; below is a large expanse of prairie which terminates in a contraction of the valley at L; finally on the other slope is a table-land with declivities very accentuated, on the summit of which is found the village M; in the distance are a succession of several ridges of elongated form, and a stretch of high poplars which seem to indicate the course of the river H.

Discussion of Its Tactical Value. As by a glance we have thus analyzed and sketched, mentally, our landscape; it is important now to appreciate its military importance and, as far as possible, to localize it.

For this we must consider a concrete case and start with a technical hypothesis; we have not done so before lest we complicate this first study, nevertheless in starting with the presumption that we are marching to the north, and that the enemy is before us, the first idea suggested by the ground that we have just taken in at a glance is that the points B, C, D, E, offer to the adversary a defensive line quite clearly defined, protected by the river H, and presenting as a position of subordinate defense the ridge K. It is here, therefore, that must be concentrated the interest of our drawing.

Setting the Boundaries of the Sketch. Our purpose is fixed; we must now mark the limits on the horizon. Limiting it on the ~~west~~ east by the bell tower B, and on the ~~east~~ west by the steeple at M, our sketch will contain all that we wish to represent.

Choice of Point of View. It is necessary also to consider placing ourselves in the most advantageous position. Point A, where we find ourselves, will not be a bad selection; it is about in the center of our subject and embraces it with a suitable

angle; on the other hand, in advancing, we risk being no longer able to perceive the ridge K and the edge of the woods that cover its summit; if on the contrary we retreat, the slopes of the ridge C and all the sloping bank in front of the village E are liable to escape us. We will remain therefore at point A, where the only disadvantage lies in not perceiving the bottom of the ravine that separates us from the ridge C; but when the work is finished we will advance a few steps which will lead us to the crest of this dead angle, of which we will mention the peculiarities on the drawing by means of a note.

Note. In that which concerns the site of the point of view, treatises on drawing advise one generally to place himself at a distance from the subject equal to two or three times its largest dimensions. We think that this rule applies particularly to artistic landscapes and to sites of small development; but in matters of military sketching, where one may record several views, one must not take this precept too literally; the main point is to clearly perceive all that one wishes to represent. As to the line of the horizon, the location of which is subordinate to that of the point of view, one can not give equally precise indications; circumstances and the object proposed to oneself will determine, before all laws of esthetics, how it must be established; certain landscapes may best be represented as a bird's eye view; others on the contrary may be more advantageously drawn when observed from a point that has but a slight command over them.

Let us remark also that in the majority of cases the main interest of the subject lies in the middle distance; one must consider the foreground as a base accurately to establish the drawing, and the background in the main as an element furnishing information to determine one's position.

WORK OF EXECUTION.

Our sketch has thus been sufficiently studied; we may now pass to its execution properly so called.

Laying Out the Work. The first operation will consist in a general placing in position and a marking of all the parts. At the two extremities of our paper let us mark first the positions of the bell towers B and M, which are the lateral limits of our sketch; next let us establish the silhouette of poplars, P 1, P 2, P 3; the first two have the advantage of cutting the horizon; as to the third, it is on the vertical prolongation of the extremity of point G, and of the ~~projection west~~ western corner of the cemetery (see fig. 21).

We have thus divided our work into four sectors, which we will proceed to fill in by degrees.

In sector 1, let us indicate the road that winds toward the village of B, and the elements of ridges distinctly visible.

In sector 2, the sides of the road AA′, the crossroad C and the four elements of roads that there join; then the wall of park C which faces us, and finally the three lines of crests A′, C and K.

In sector 3, which is a little larger, we will devote our attention to establishing as accurately as possible the bell tower of the village E, as well as the different roads abutting thereon, the lines of successive ridges that one perceives, the south wall of the cemetery and the bend of the river at L.

Finally, in sector 4, let us indicate the wall of park F, the banks of the river and the bridge G, with the road that prolongs it; then, to terminate, the crest of the table-land M. It goes without saying that this preliminary work must be executed with as light a stroke as possible, lest we be embarrassed in the execution of detail which we are about to approach (fig. 19).

Execution of Details. Returning successively to each of the sectors (1, 2, 3, 4), we will now draw in the different details, beginning preferably with the foreground. This method of procedure insures very easily the placing and the accuracy of proportions, for the objects of the foreground, always larger and more simple in their lines, become very useful guiding marks for establishing more remote objects. In sector 2, for example, one will find assistance in the different vertical coincidents aa′ a″, bb′ b″, cc′ c″, dd′ d″ (see fig. 20).

One must also proportion the strength of the stroke inversely to the remoteness of the objects which one is sketching.

Bear firmly in the foreground;

Normally in the middle distance;

Very lightly in the background;

The lines will then have for each of the zones the relative textures shown in fig. 20.

Note. In the execution of detail it is very difficult not to lose oneself in a mass of minutæ. One should confine his attention strictly to what it is essential faithfully to reproduce; for this it is indispensable that the mind work at the same time as the pencil. In drawing, for instance, the village E, should one devote his attention to representing all its houses? Evidently not; what is there then of importance to take notice of here?

Its bell tower, the shape of which is clearly recognizable; the group of houses placed in rows one above the other ~~on~~ the eastern part, which leads one to suppose that the village may extend beyond the ridge; its cemetery which flanks it on the west and which we will indicate by a very visible cross as in topography; finally the walls of its southern extremity, the military importance of which is unquestionable (fig. 21).

Representation of Slopes. The crest lines being already established, it only remains, in order to finish the drawing, to represent the slopes of the ground by the method previously indicated (curves and perspective hachures), as before proportioning the vigor of the stroke inversely to the distance (fig. 21).

But contrary to the course indicated for sketching the silhouettes, there is advantage in beginning the representation of the ground in each zone with the most remote distances, disregarding be it understood the too distant inclines, which one can hardly appreciate and which are therefore sufficiently indicated by their crest lines.

Explanations, Notes, Putting in Ink. Considered as a drawing our panorama is finished; but it will gain enormously by the addition of some written notes in the upper margin; these will give the names of localities, ranges, information as to the practicability of the ground; in a word, all sorts of detail which the military sense will suggest, and which will transform the sketch pure and simple into a very useful reconnaissance record (fig. 21).

Finally, and to end this theme, we would advise, whenever it is possible, that the drawings and writings be traced with ink: the time thus occupied is insignificant; on the other hand, one will thus produce a durable document of which the neat and strengthened drawing will inspire confidence and certainty.

Note. Hesitation and inevitable slowness in first exercises of this character, executed on the spot, must not discourage the beginner, for these defects will disappear very quickly as he perfects himself in the process. He will notice then that the work of conception is generally the key to the situation, and that the drawing will become relatively easy when the mind has been drilled thoroughly to comprehend.

PART IV.

APPLICATION OF THE LANDSCAPE SKETCH IN CAMPAIGN.

HAVING learned to execute a landscape sketch, let us see how we can turn the knowledge to account in certain cases that may present themselves in campaign.

Essential Principle. Never make a sketch with the sole aim of sketching, or of putting in evidence a personal talent, but employ it without fear whenever you may have the time for it, or the possibility, and when by this means you are able to make clear a description or simplify a report.

Landscape Sketches in Connection With a Topographical Sketch of an Itinerary. Such sketches are of undoubted value in indicating the visible horizon, when this horizon offers interesting peculiarities; their use is especially suggested in mountainous or broken country, covered and wooded, where level stretches are rare and isolated, and finally in regions little known, which one surveys for the first time, having maps incomplete or very general (Southern Algeria, Madagascar, etc.).

Such work is then but a succession of very brief sketches, which one might compare to a succession of windows opening upon the horizon; ~~and~~ they have, ~~further,~~ the advantage of prolonging the record of the scene beyond topographical limits.

Example. I sketch the itinerary of a road A B which runs through a wooded region, not permitting me, save at rare intervals, to judge the surrounding country (fig. 22). My topographic map thereby finds itself unfortunately limited; I will supply the deficiency by landscape sketching. Arrived at C, I emerge from the

wood; on the right the horizon discloses itself and enables me to perceive certain marked peculiarities of the country (a stream of water of average importance, a bridge, several mountainous crests, a village with characteristic tower, a castle, and on the summit of an elevation, lines distinctly outlined which resemble strongly epaulements of a battery). It is a suitable occasion evidently to note what I am able to see by means of a rapid sketch. Shall I make a complete landscape? Certainly not, the itinerary is always a pressing affair; one must go far and operate quickly to see the utmost possible; besides the details of all these distant objects are useless; the essentials are their relative positions and the general features which permit of their recognition; all these can be indicated in a sketch of few strokes. This sketch I will establish on the same sheet with my itinerary, orienting the visual angle as exactly as possible with regard to road A B.

A peasant passes. I stop him, and whilst drawing, I question him upon what I perceive. The information which he gives will be embodied in a legend which I will place near the sketch on the margin of the paper reserved for this purpose. I continue my itinerary; the road A B enters some woods; arrived at D, the scene unfolds a second time,—new perspective, new horizon; the moment is again opportune for executing a landscape sketch analogous to the preceding, in spirit as well as in composition (fig. 22).

Landscape Sketches in Connection With a Reconnaissance Itinerary. In the course of a reconnaissance of a country, if one encounters certain positions offering special interest, the study of which is necessitated by tactical considerations, there is great opportunity to elucidate matters by means of landscape sketches.

Example (fig. 23). I belong to a column that has reached A, and the following day must advance toward B; the enemy is signalled at B′, and seems to have A for objective; a chance battle appears likely to occur. I am charged with reconnoitering the road A B which the column must follow. I make use of a ~~chart~~ map leaving some doubts that must be cleared away. Before starting I study my ~~chart~~ map and prepare a rough sketch upon which to record all my observations. I traverse the distance from A to B, observing attentively the country, correcting here and there some topographical details upon the ~~chart~~ map. The road

is good, well kept, and the surrounding country is practicable and rather open. Arrived at B, I gather what information I can concerning the enemy and I make ready to turn back. During the trip from A to B two peculiarities struck me:

1. The crossing of the river R, which we could advantageously dispute with the enemy;

2. A flank position on leaving B, where the enemy, on the contrary, could give us combat under conditions, with respect to terrain, entirely to his advantage.

These are evidently the two important discoveries resulting from my reconnaissance. Moreover my attention is especially drawn to them, since a combat is imminent for the following day. Shall I make this the object of a special report? No, the description of a country or of a position is generally complicated and diffuse, in consequence of its inevitable tediousness of style; besides one has always to fear saying too much or too little about it.

A topographical sketch would but repeat what will be shown on the corrected ~~chart~~ map. But landscape sketches are documents that can not fail to interest the commander of the troops; they illustrate the country as it will present itself to him and to the enemy, upon the hypothesis of an encounter at one of the points mentioned. ~~These impressions I can convey by means of landscape sketches.~~

In returning toward A, I arrive first ~~at~~ before C, and I consider the ground from the standpoint of the enemy. It is bare and exposed. The ~~chart~~ map, moreover, gives a clear ~~ly an~~ idea of it. Under these conditions my sketch will probably be more useful if executed inversely, that is to say facing toward point B, and in consequence toward the enemy.

I stop then at a spot O, whence I discover the position C in its entirety, and I begin the first sketch. This sketch will not be fastened, as in the preceding case, upon the leaf of the itinerary, but upon a special leaf which will be joined to it; it thus admits of a certain elaboration and demands a little breadth for facility of execution, nevertheless above all things one must operate rapidly. The sketch must indicate the different military peculiarities that offer interest in view of the existing tactical situation, since it is a case of a defensive position likely to be occupied by the enemy. I must in consequence show the different lines of resistance, points of support, character of flanks, etc.; and the whole is completed by a few notes as shown in the figure (fig. 24).

I then continue on my way toward A and arrive at the crossing of the river R, facing the second position noted. All interest centers upon the bank on the side of A, which dominates the other bank and constitutes a position that we could occupy advantageously to bar the passage of the enemy. From the point O′, where I find myself, one discovers perfectly the character of the position. On the other hand, the bank on B side is without cover; nothing there obstructs the view and the firing; it is therefore preferable to make the sketch from the side of B just as the enemy will perceive it in advancing toward A. I will execute this second sketch in the same spirit as the preceding one, that is to say, with a view to the tactical idea, which is here the defense of a bridge, in order to bring out such details of terrain as seem destined to play a *rôle* in the combat (fig. 25). Before completing my work I will take care to indicate on the leaf of the itinerary, the orientation of my two sketches by means of their visual angles (fig. 23). In many cases one will not have the time needed to finish the sketches as in figures 24 and 25; for this reason one must begin with the most essential things from the military point of view; military crests, edges of woods, hedges, walls, rivers, banks of streams, etc.

A sketch unfinished as to drawing, properly speaking, but complete as to lines of generalization (*ensemble*), can be retouched perfectly well if one has care, before leaving the terrain, to make a careful examination. Besides even an unfinished sketch would be a useful document to bring back from a reconnaissance.

Specimen of Itinerary with Silhouettes of Landmarks, to Serve in Night Operations. Finding one's way being much more difficult at night than by day, it is useful to represent upon an itinerary details of the route easily to be noted in darkness. One must in consequence select a nearby view-point and reproduce the silhouettes very faithfully on the margin of the itinerary or of the diagram, alongside of the scale and having regard to distances (fig. 26).

Specimen of Landscape Sketch for Artillery Reconnaissance. This is one of the cases where the sketch will be of very appreciable interest; for in giving an exact idea of the visible horizon, maskings and coverings of the ground, one is able to illustrate the value of this or that artillery position.

For sketching one should establish himself on the line to be occupied by the batteries, where one will usually have as fore-

ground the crest destined to serve as screen to the guns. In the middle distance one should indicate dangerous localities to which the infantry of the enemy could penetrate under cover and, *per contra*, the positions that the support could occupy advantageously. The background will necessarily possess the greatest interest; one must sketch it distinctly and with care to a distance of at least 2,500 meters There should be indicated the most visible reference marks for firing, with estimated distances noted; the different lines of ridges upon which the enemy could eventually establish his artillery; and the cover and shelter susceptible of concealing his march to the position of combat (fig 27).

Sketch of Outposts. A landscape sketch accompanying a report on outposts will generally simplify such report and make it clearer; besides it will permit one to judge of the correctness of the dispositions made and to appreciate to a certain extent the strength of the lines of resistance. In consequence, whenever one has the time to undertake it and the horizon is adapted to the task, landscape sketches should be made. One should place himself, for drawing, upon the line of resistance, and when possible, near the site chosen for the artillery, for it is from this point that one will probably have the most extended view.

One must bring out the general character of the ground; the exposed zones and those over which visual supervision and fire command are more difficult; routes of communication; and finally the different echelons of the outpost (grand guard, picket posts, special posts, etc.), as well as the successive lines upon which they could resist (fig. 28).

The disposition of outposts usually admitting of a great development, the drawing will be composed of a succession of sketches taken sometimes from different points. One should mention the orientation on the topographical sketch attached to the report, or in its absence, upon an index map added to the landscape sketch sheet (fig. 29).

Sketch With Field Glasses. Circumstances will often present themselves where the presence of the enemy forbids approach to positions which one wishes to observe and study close at hand. One can nevertheless bring back from such reconnaissance useful documents in the shape of landscape sketches, ~~drawn by means~~ made with the aid of field glasses. Let us consider for example the following hypothesis (fig. 30): the reconnaissance of a coast has for its object the discovery of points fit for debarkation in view of a combined move-

ment by land and by sea near the port A; the beach B seems to fulfill the necessary conditions. The representative of the commander of the land forces, who is one of the reconnaissance party, must give his advice upon the tactical possibilities of the enterprise. Among other considerations he must especially appreciate the value of the positions that surround the beach:

1st, from the point of view of their accessibility and of the facility with which one may establish himself upon them;

2nd, in that which concerns their defense against attack by the enemy, since they must constitute a first base of operations. This involves necessarily an attentive study of the two slopes of the ridge C, and of the point D, which forms a salient where probably the first launches will land. To record observations upon this inaccessible terrain, the most practicable expedient will consist of a succession of landscape sketches ~~executed~~ each made as follows: execute with the naked eye a hurried sketch, and a very light one, of the broad lines perceptible and easy to recognize; this sketch (fig. 31), should be sufficiently large to contain details that field glasses will permit one to distinguish and that one draws in proportion as one sees them, beginning by preference with those nearest, which serve thus to constitute a foreground (fig. 32).

There is no denying that this style of work is very fatiguing to the eye and to the mind; one must limit it to what it is strictly necessary to note, without seeking to elaborate. On the other hand it is a process that may be employed in relative security and that enables one to bring back information which it is essential to obtain. The sketch of the beach B (fig. 32) records the following facts:

1st, that to oppose itself to the disembarkation, the enemy could occupy the crest C, a commanding position which seems to dominate the beach;

2nd, that quite close to the shore the assailant would be able to find shelter behind the farm E, the little cliff G, and the sand hills H, whence he could reply to the fire of the defense; that he would have before him a series of hedges favoring an advance by bounds; that the position C seems more readily accessible toward its left flank, thanks to the fir plantations that are found there; finally, that a carriage road leads from the beach to C, a circumstance that will permit a ready advance of the artillery, once the position is occupied.

Such considerations evidently possess value in computing the

chances of the enterprise and a sketch will emphasize them far beyond the possibilities of a simple written report.

The Hasty Sketch. The different sketches hitherto described and shown in the figures are entirely finished and, what is more, traced with ink; under such conditions they do not perhaps give a fair idea of the work that one can execute on the ground itself.

A drawing in the open air is not made with the same facility as before a table, where one can give to the stroke all the care desirable, and make, strictly speaking, a topographical miniature; one must therefore adopt a size sufficiently large, with the reservation that it be not cumbersome and be easily portable.

Since landscape sketches extend generally in the direction of breadth, and since one has every advantage in being able to unite them, a stub notebook, from which the leaves can be easily detached, say 30 to 40 centimeters in length and 10 to 15 in height, and fastened together with a rubber band, would seem to fill the desired conditions. The black lead pencil, soft and easily controlled by the hand, giving at will a stroke firm or light, is ~~preferable~~ the natural tool for sketching; nevertheless in certain cases, and to avoid confusion of the lines, there will be advantage in making certain indications with colored crayons; burnt sienna or brown for the representation of bare ground, green for vegetation, blue for water, red for military lines, works, positions, etc.

In what concerns the execution properly so called, every sketcher must tend to create for himself a certain number of conventional signs in order to abridge his work and prevent its becoming overloaded with detail.

It is above all for objects of ordinary form and occurrence (houses, walls, farms, roads, hedges, etc.) that abbreviations have their greatest value, and it would really be wasting one's time to draw them completely; one notes simply the characteristic elements of their silhouettes. Furthermore it is not indispensable that the representation of the terrain should be invariably complete and continuous; one will make it so at the essential and critical points, deferring the adjustments and the harmonizing of detail until the end; but for all that, one must take the trouble to observe and to see; for variations of the ground are not to be invented.

In short the memory is easily developed to the recollection of lines and of forms, provided one observe and observe constantly; and a few strokes later will suffice to recall all the clearness of the impressions. The few sketches (fig. 33) will indicate however,

better than words, the spirit in which one must sketch to arrive at an execution at once rapid and correct.

Water Color Sketching. Water colors have their use in military sketching when one is not hurried, and when the importance of the document justifies the necessary expenditure of time. Its aim is not to produce a work of art, but to render more clear and more comprehensible a drawing carefully executed with line work. It goes without saying that the washing in is not done in the field, where one will find a more judicious use for his time in sketching with the pencil as careful a draft as possible. In the field the eye contents itself with observing the general color tones presented. Once returned home, after having very clearly finished the pencil drawing, one may proceed to the washing in with flat tints, giving to each object the local tone observed without being too intent upon rendering faithfully the shades, which are, for that matter, essentially changeable, according to the light, the season, and the more or less advanced condition of the tillage. Begin with the sky, broadly suggested and without attempting any special effect, which would here be a superfluity. It is not a question of rendering a particular effect of light, but solely of rendering more striking a drawing whose greatest value lies in its line work. The hypothesis of a diffuse light is the most advantageous one to adopt, since this does away with indicating the relief of objects and the shadows they cast. After having executed the sky, one will pass to the background, which is generally of less interest and is called upon only to furnish the data of orientation. Here one will content himself with a bluish gray tint, more or less dark according to remoteness; this will have the advantage of bringing out well the values of the ridges, at the same time making them recede.

Next come the middle distances, where one will employ suitable local tints, avoiding always vivid colors, which one must reserve for the foreground, with which the washing will terminate.

After the tints are dry, go over the sketch with a pen in part at least in order to bring out clearly the essential details. From an artistic point of view it is possible that the water color will thereby lose, but it will certainly gain from a military point of view.

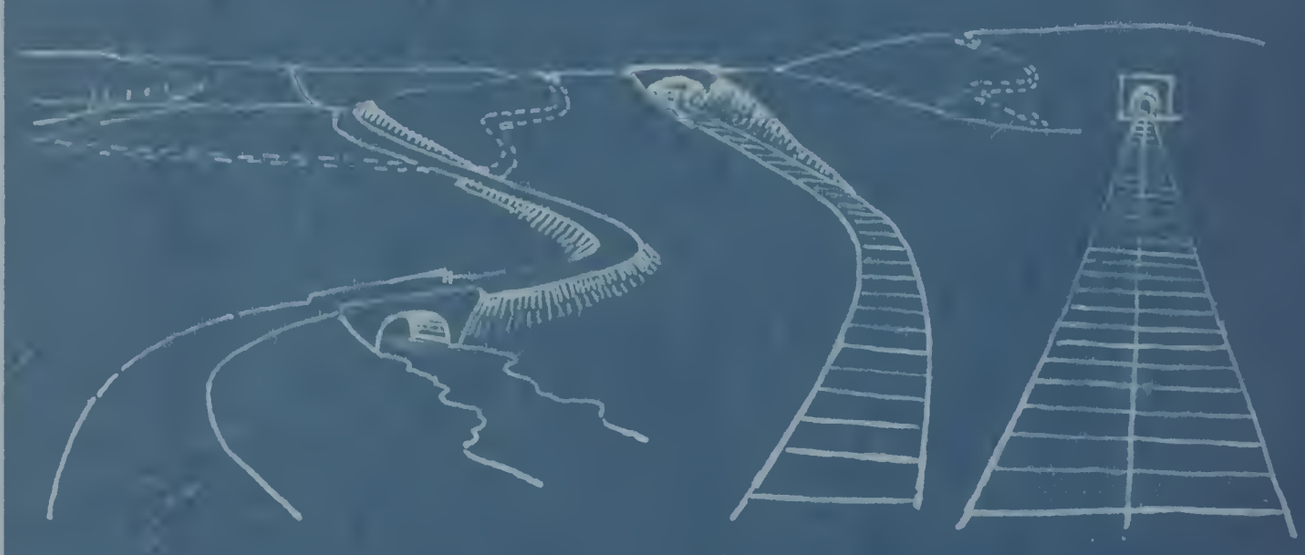


Size on Map from 0 - 500



from 500 - 1000 beyond 1000
Metres.

Fig. 1.



Single Track. Double Track.

Fig. 2.

Plate I.



1st Order.



2nd Order.



3rd. Order.

Fig. 3.





Fig. 4.

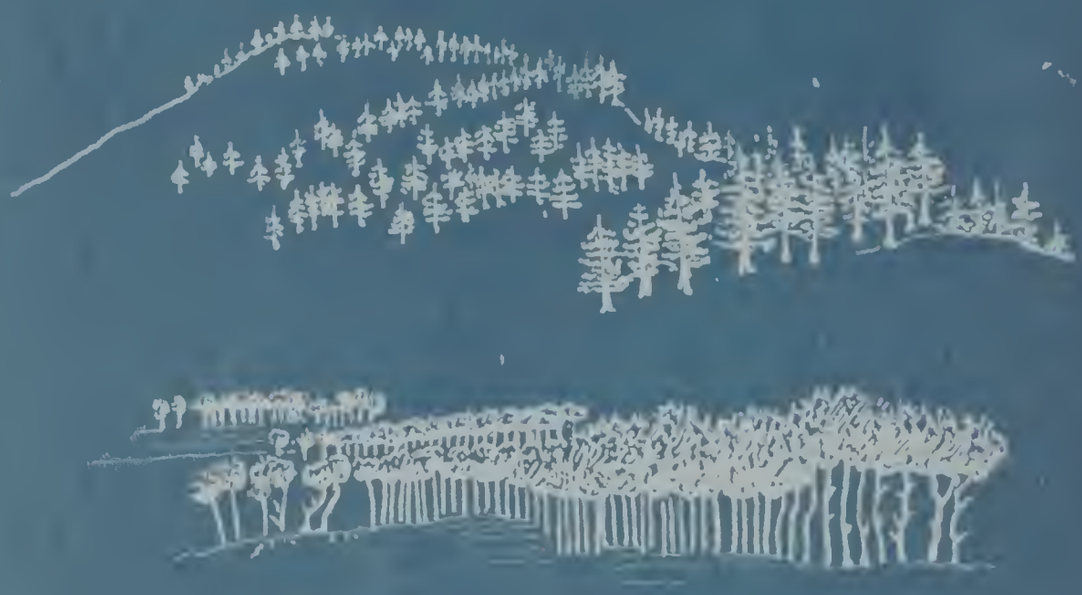


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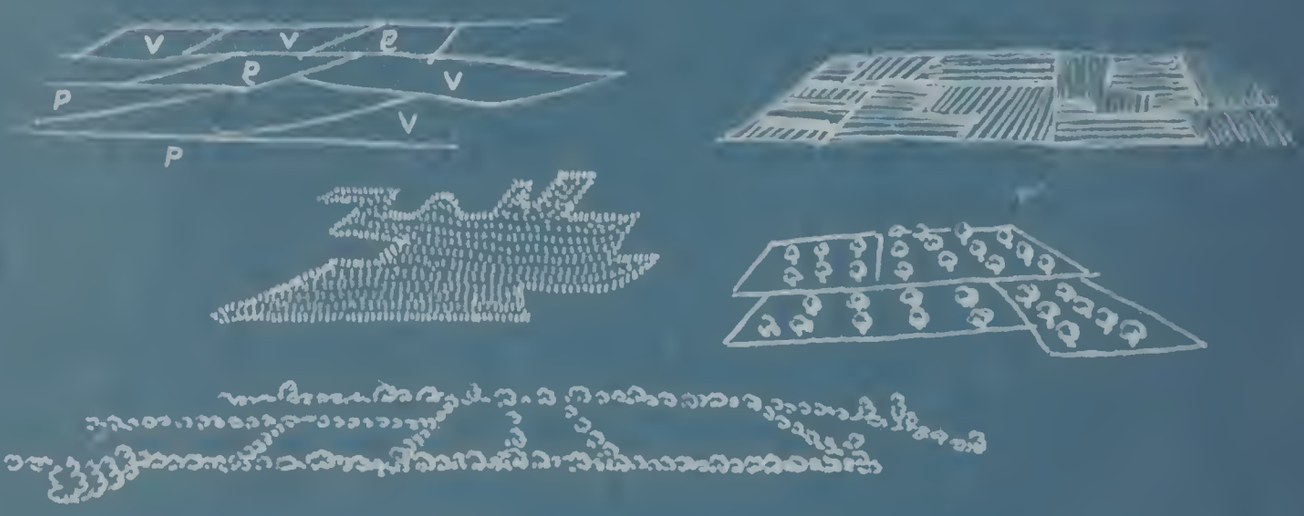


Fig. 6.



Fig. 7.

Plate II.



Fig. 8.

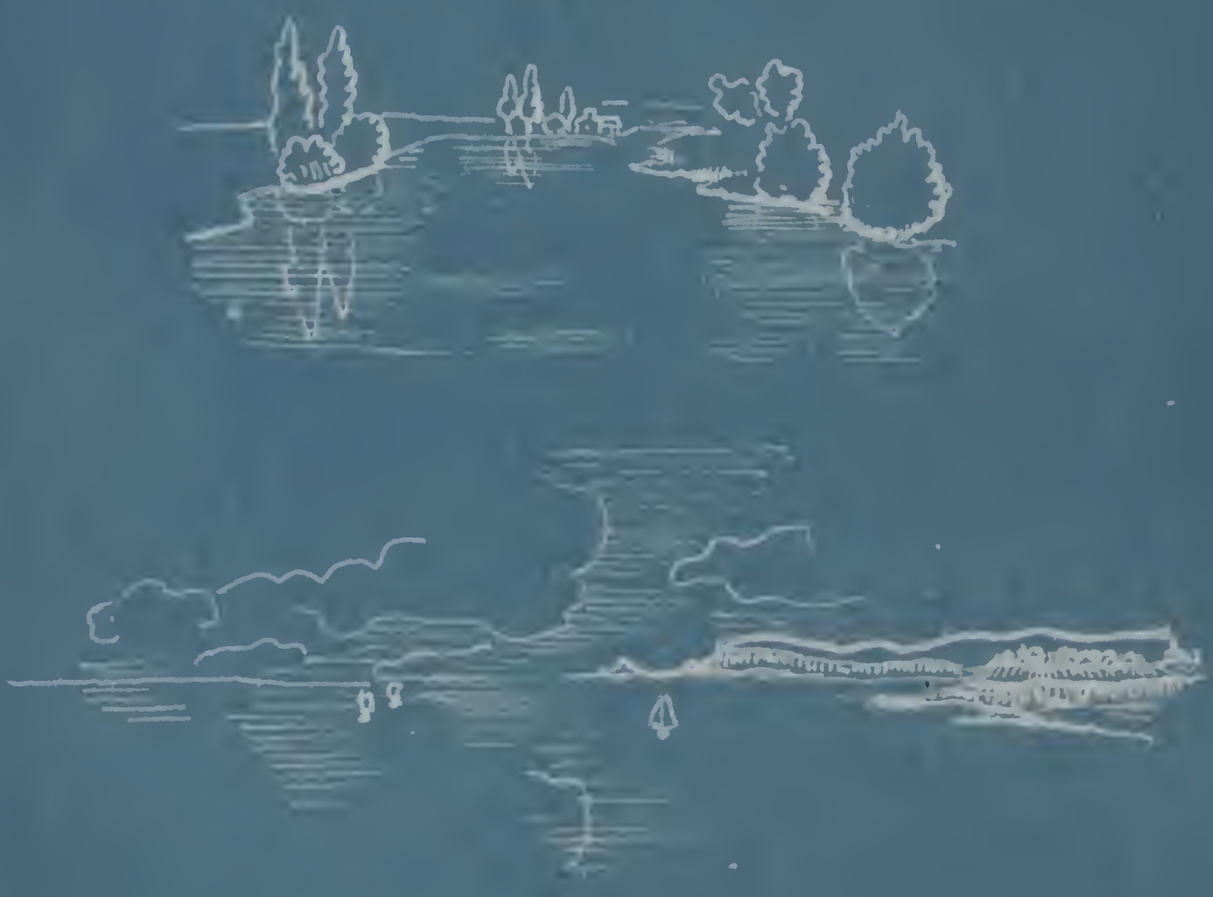


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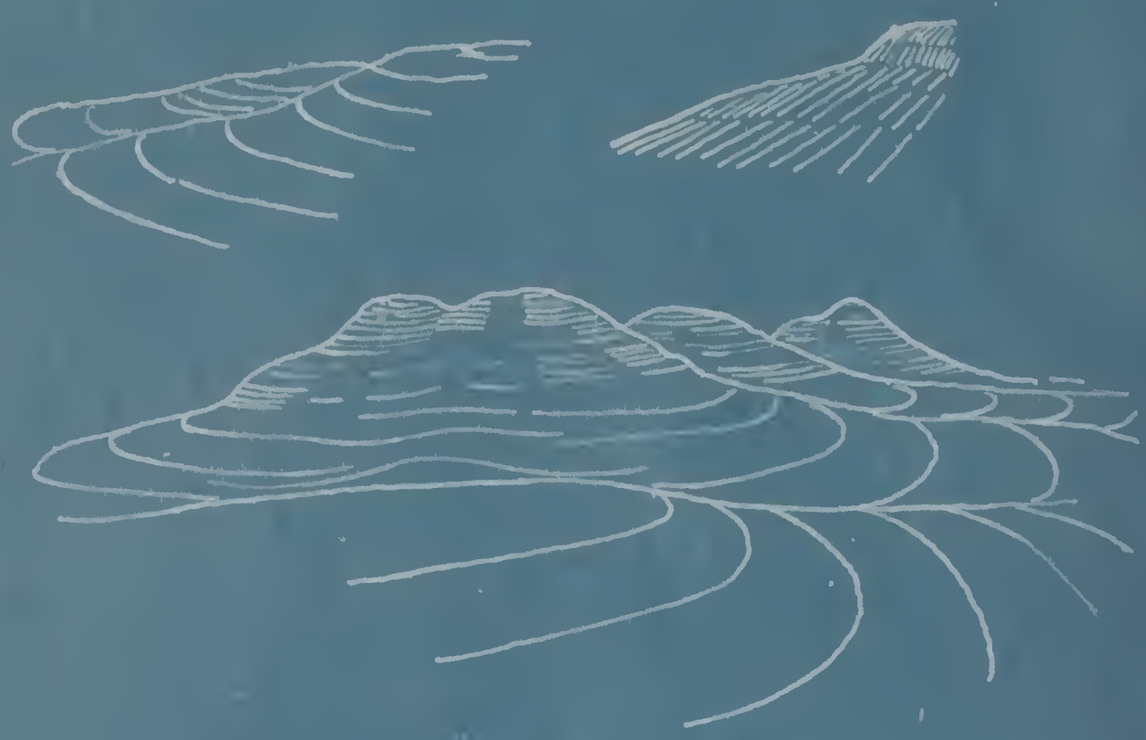


Fig. 10.



Fig. 11.

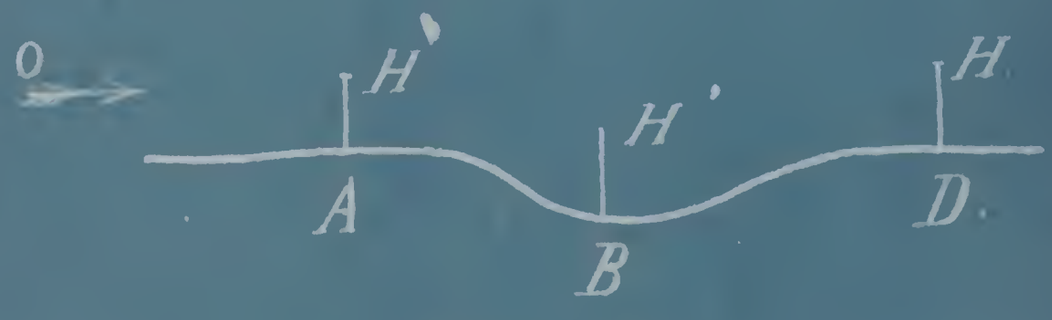


Fig. 12.

Plate III.



Fig 13.



Fig. 14.



Fig. 15.

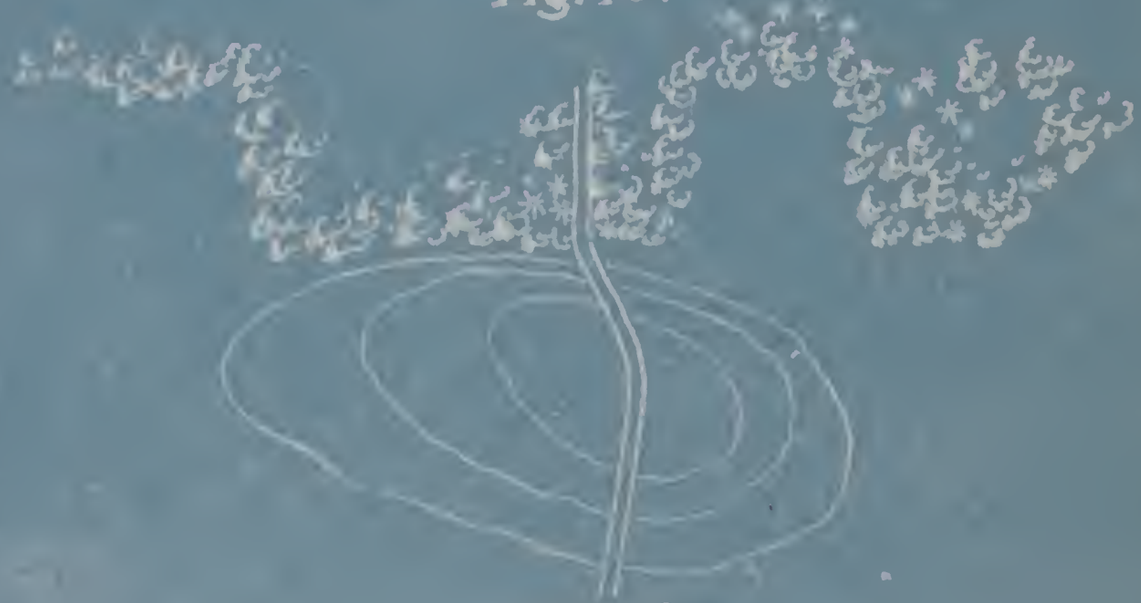


Fig. 16.



Fig. 17.

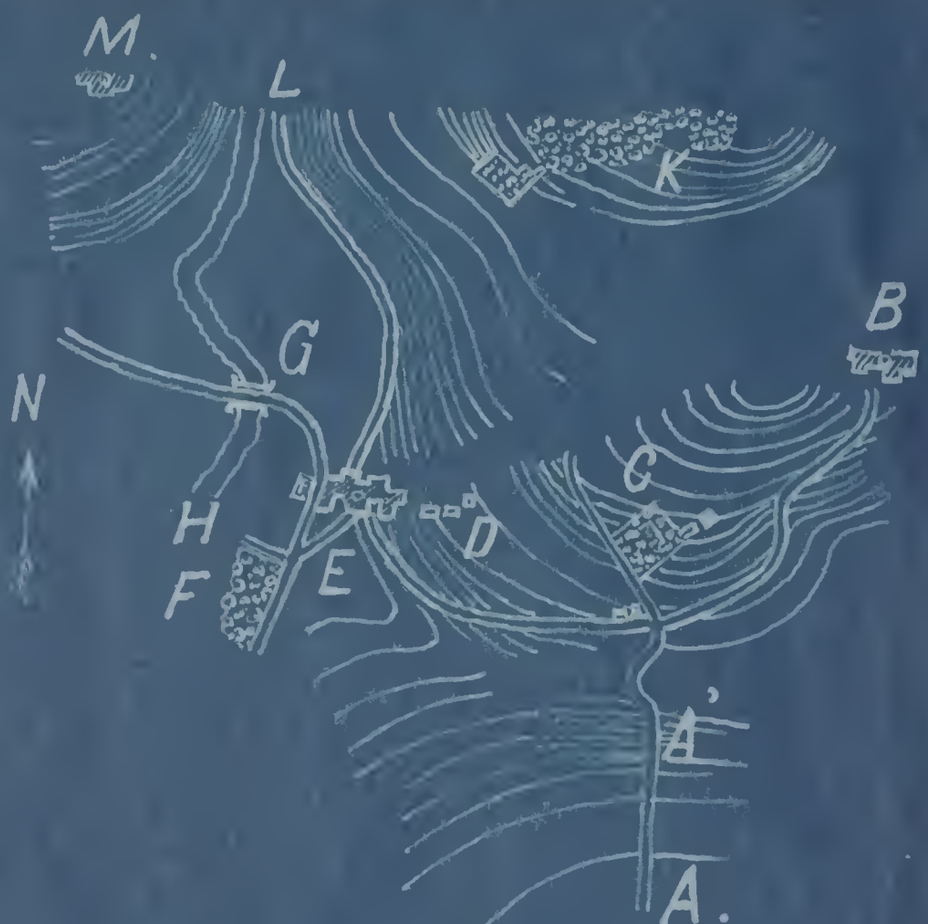


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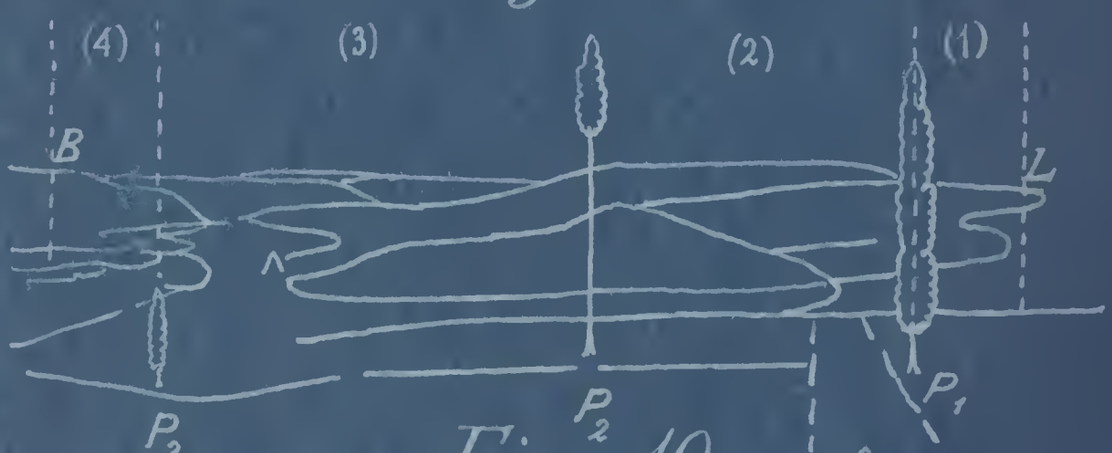


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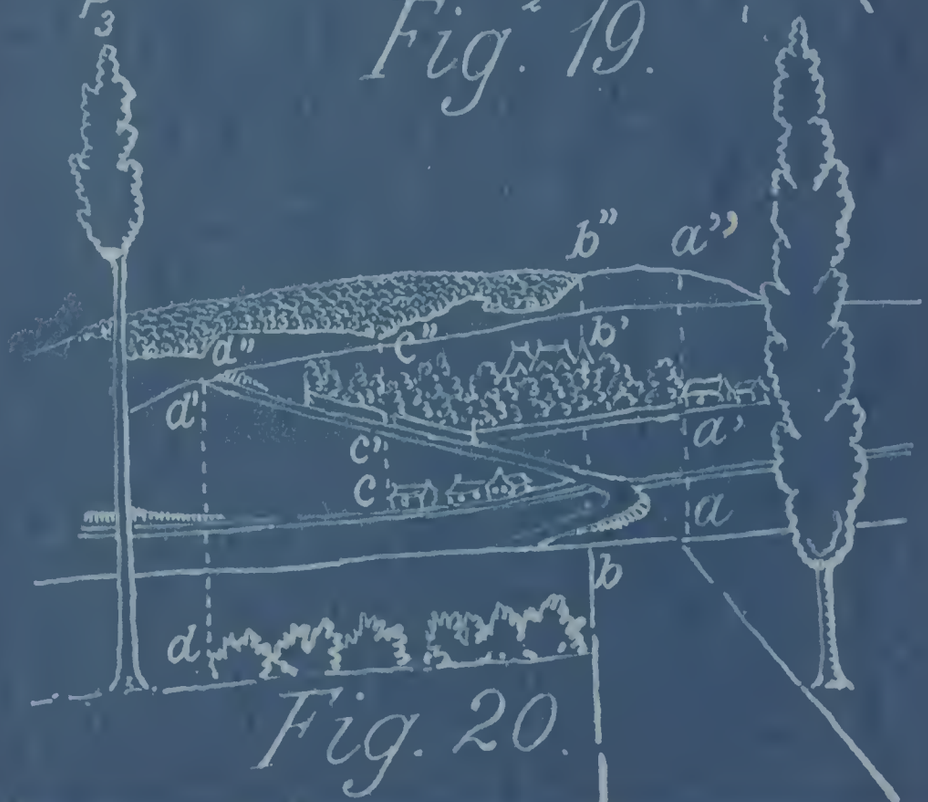


Fig. 20.

Plate IV.

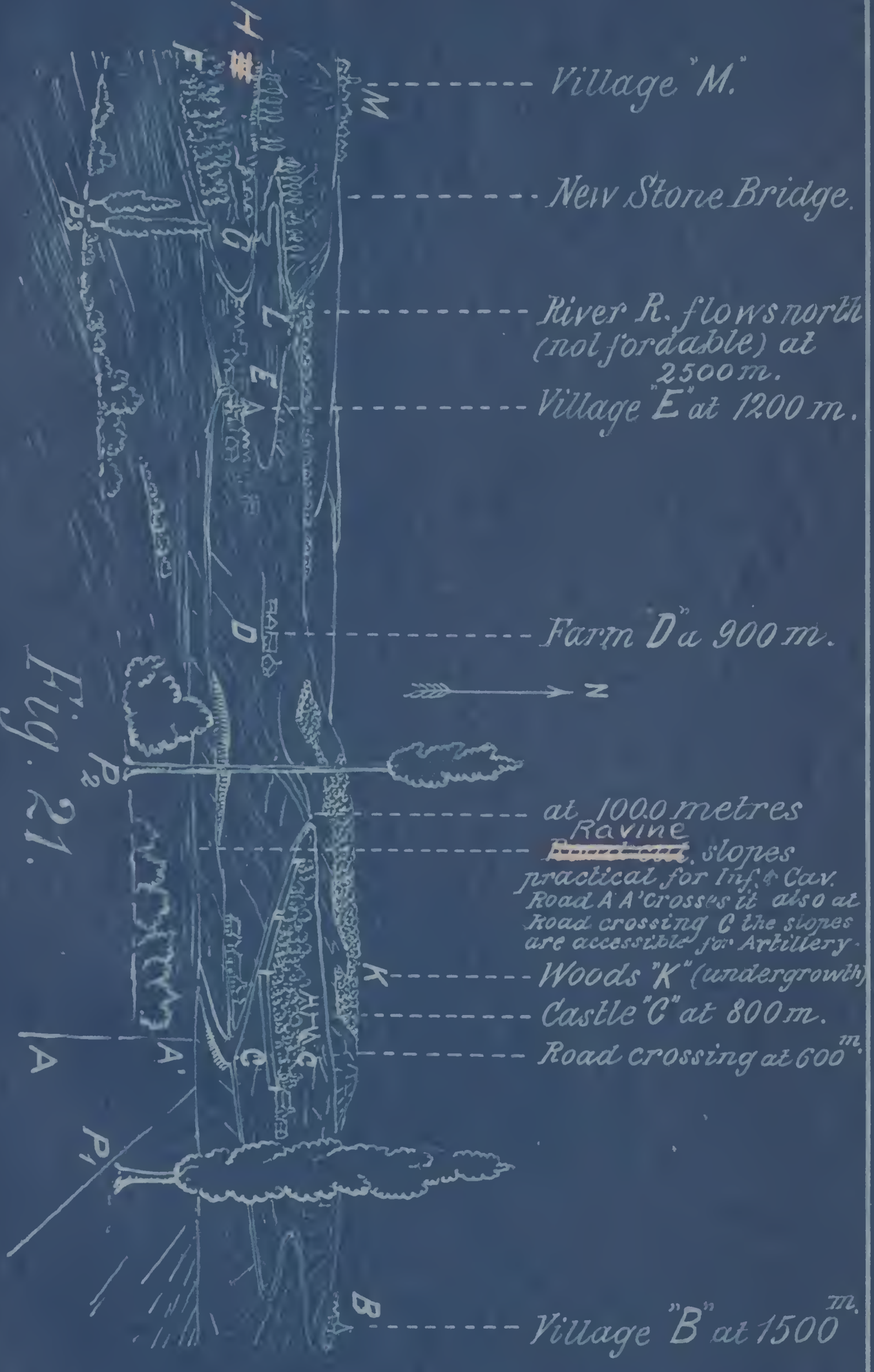


Fig. 21.


l
K
h
g
f
e
B
2nd Panorama
Mountain e
Sharp peak f
g Village of 80 chimneys (hearths)
Pass ~~Neck~~ "h" at 2 hours walk from Village "g" Trail leading through Dairy-farm "l"
K. Rounded mountain top.
N.
D
2nd Panorama.
a
c
b
a
1st Panorama
1st Panorama →
C
A.
Mountain Fort, "a"
Village "b"
Castle "c"
Bridge across riv. d in bad condition.
Average width of river 40m. not fordable anywhere current very strong.

Fig. 22.

Plate V.

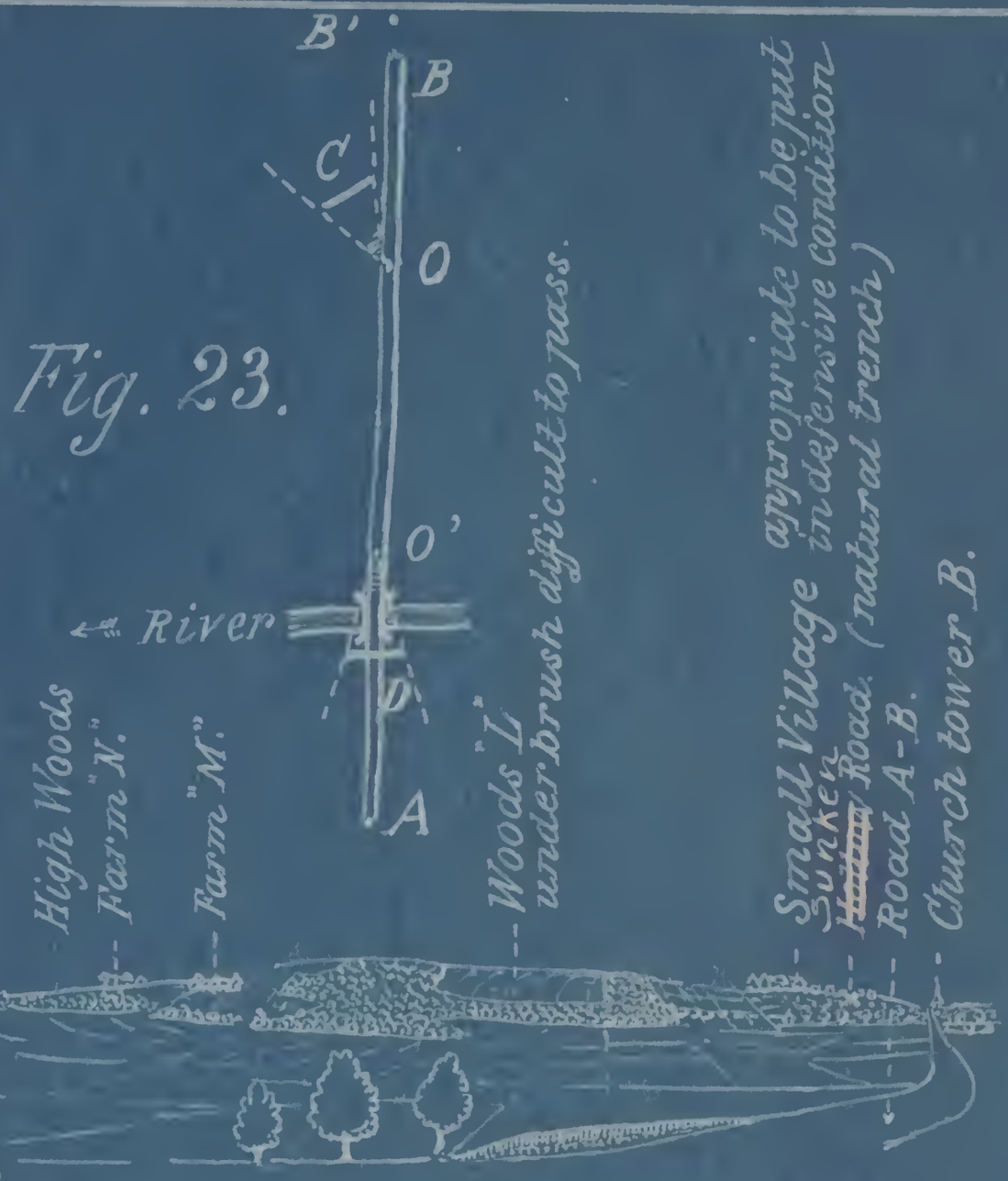


Fig. 23.

Fig. 24.



Fig. 25.


1 Kilometre.
2. K.
3. K.
4. K.
5. K.
6. K.
7. K.
8. K.
Road to be followed
Road to be followed.

Fig. 26.

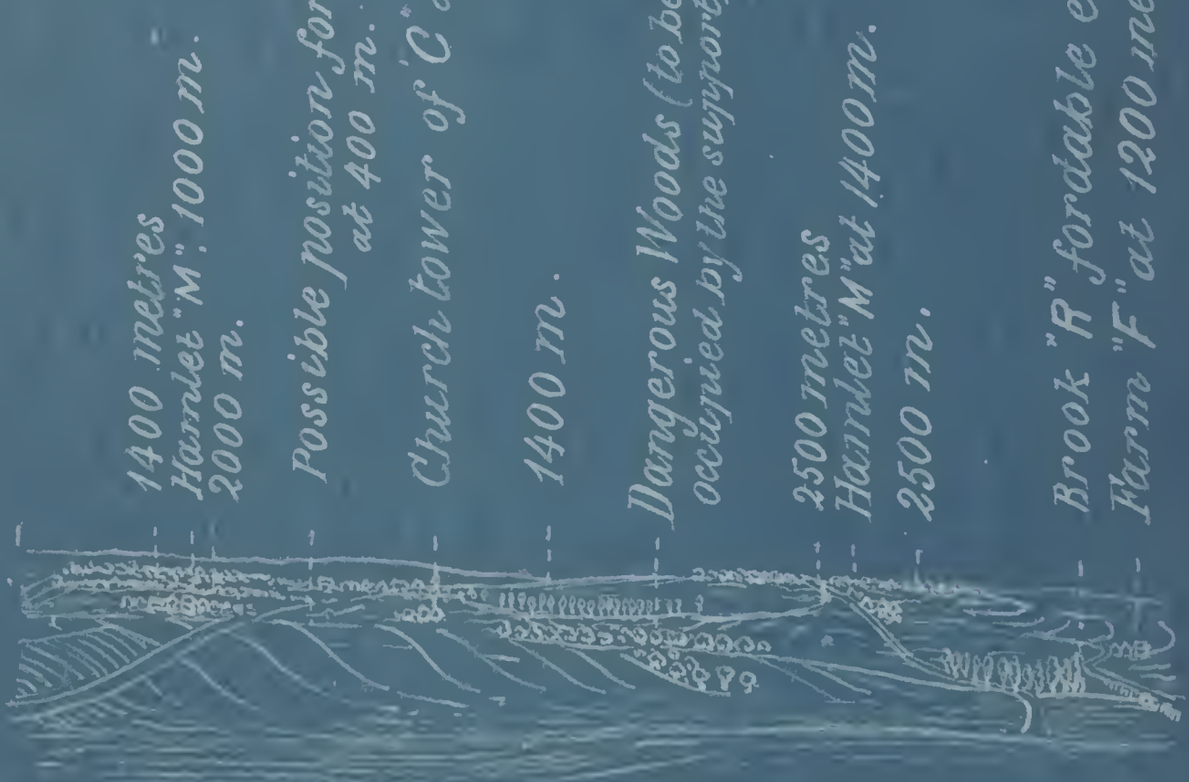

1400 metres
Hamlet "M" 1000 m.
2000 m.
Possible position for support at 400 m.
Church tower of 'C' at 3000 m.
1400 m.
Dangerous Woods (to be occupied by the support)
2500 metres
Hamlet "M" at 1400 m.
2500 m.
Brook "R" fordable everywhere.
Farm "F" at 1200 metres.

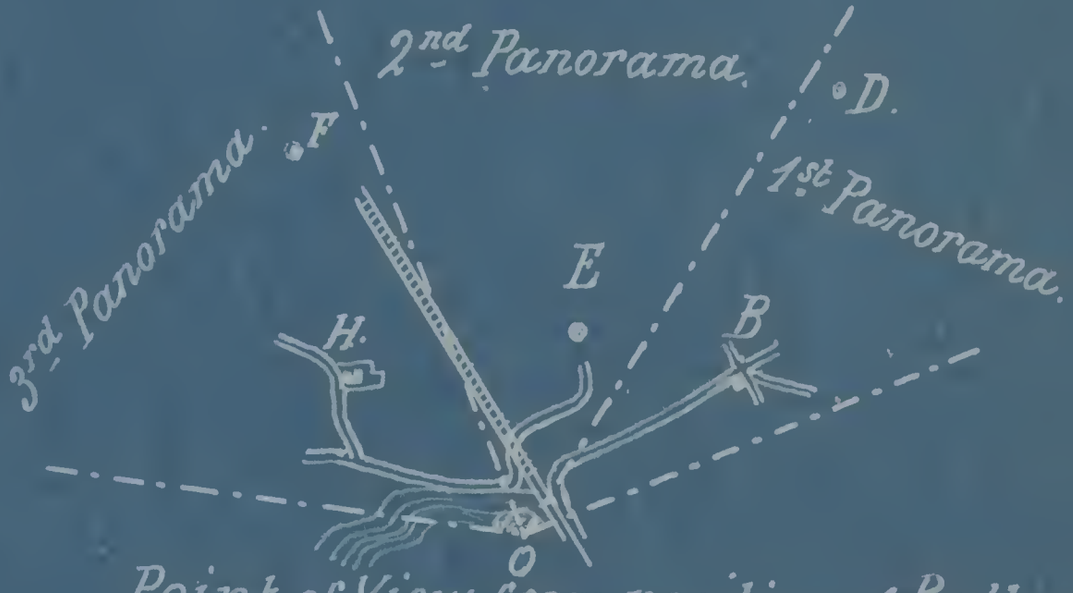
Fig. 27.

Plate VI.



3rd Panorama.

Fig. 28.



Point of View from position of Battery O.

Fig. 29.

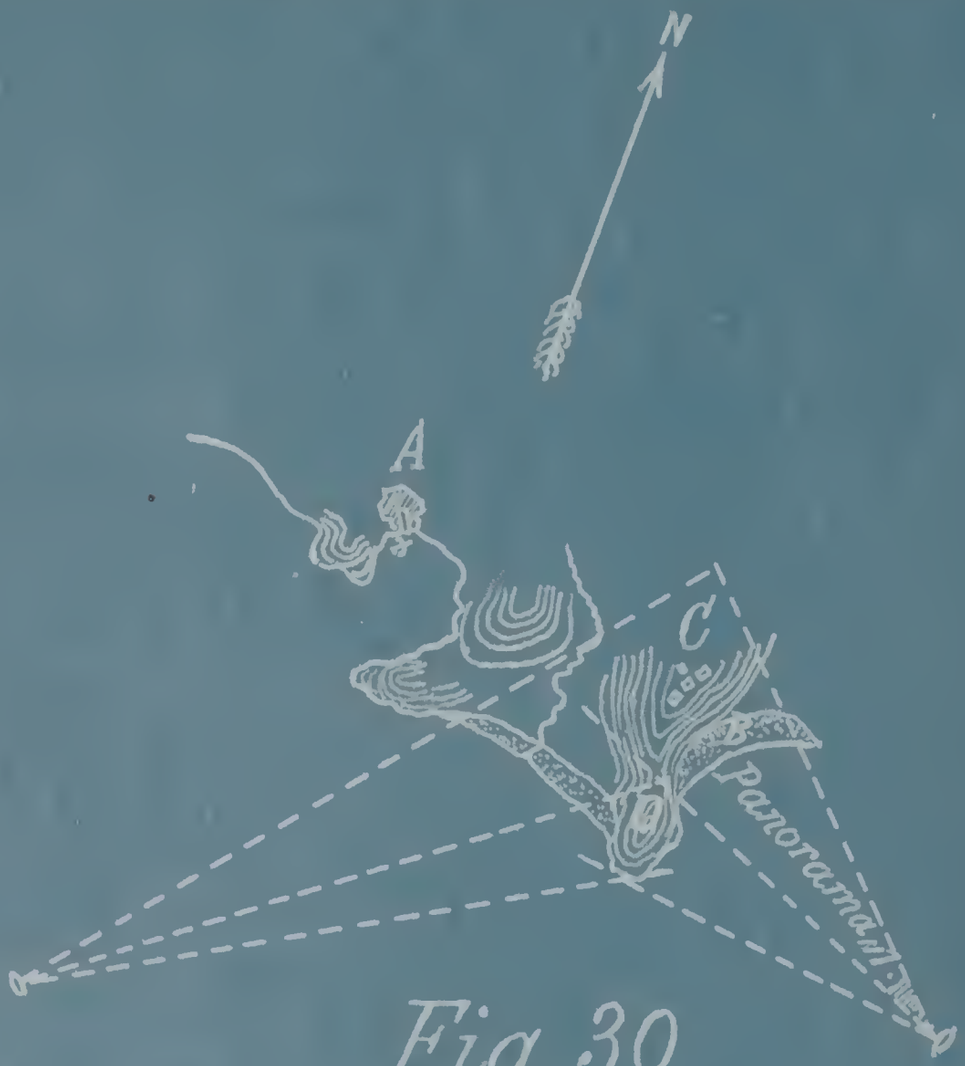


Fig. 30.

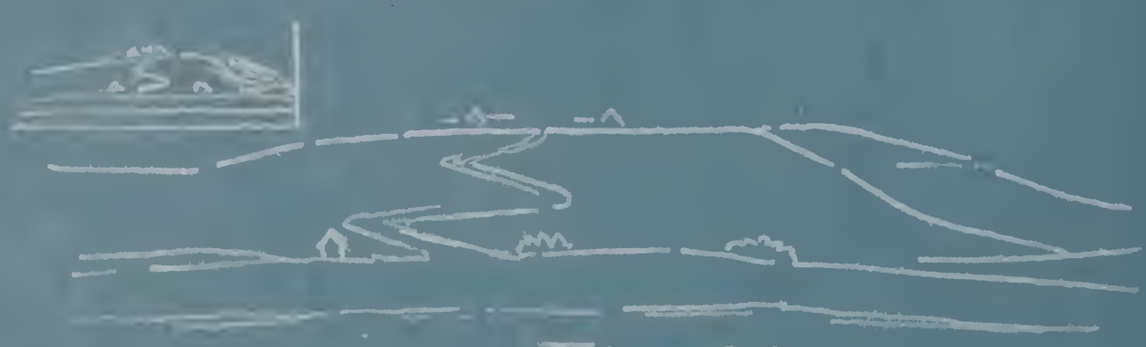


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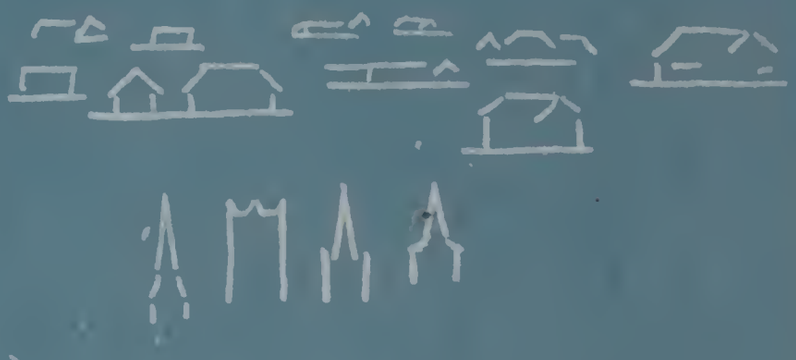


Fig. 32.

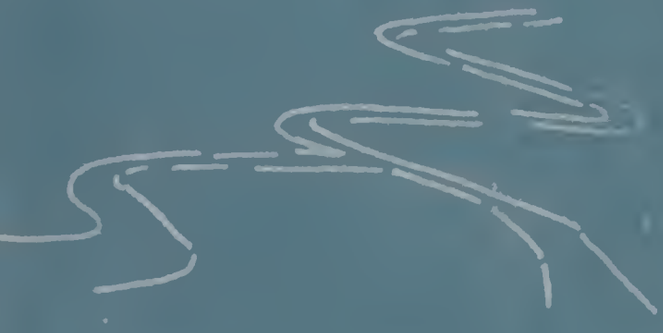
Plate VII



Stone and Hedge fence.



Dwellings.



Roads

and



Railroads.



Fig. 33.

THE

DESTRUCTION OF OBSTACLES

IN CAMPAIGN.

BY

MAJOR BORNECQUE.

With 42 illustrations in the text.

Translated from the French by

Captain Edward Burr, Corps of Engineers, U. S. Army.

PRESS OF THE ENGINEER SCHOOL OF APPLICATION,

WASHINGTON BARRACKS, WASHINGTON, D. C.

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TRANSLATOR'S NOTE.

Major Bornecque's monograph deals, as he states, with the subject of Demolitions or the Destruction of Obstacles in Campaign only in their relation to the work of tactical troops, mainly the infantry and cavalry, and intentionally omits serious treatment of the more systematic and extensive operations of technical troops, the engineers, along the same lines. It contains, however, some considerations that are worthy the attention of all officers and warrant its printing in English although in many respects his treatment of the subject is sketchy.

The material and methods described are those of the French land forces and among the former appears melinite as the high explosive adopted for all uses in the field for which black powder is not suitable. Melinite is supplied to the troops in cylindrical and rectangular cartridges inclosed in metal cases. The former are called *cartouches* or cartridges; and the latter are known as *pétards*, and this word has been retained in the translation for want of a better one distinctive from cartridge. The petard form is distributed to all regiments of infantry and cavalry in quantities that will be found in the text.

Little information is given regarding melinite outside of the makeup of the cartridges and petards and the methods and quantities to be employed in various demolitions. It is, however, stated that dynamite (presumably dynamite No. 1), may be substituted for melinite and is equally powerful weight for weight although of less density and therefore of greater bulk than the latter. For reasons other than their relative strengths, melinite

has replaced dynamite in the French army and, assuming them to be of equal strength as stated in the text, all of the statements as to weights of charges may be considered as applying to dynamite No. 1.

For the convenience of the reader, all formulas and quantities have been transposed from the metric to the English system of units. In all instances the transposition is no more exact than the circumstances appear to warrant.

WASHINGTON BARRACKS, D. C.,

AUGUST, 1902.

PREFACE.

It is certain that in future wars, even more than in the past, endeavors will be made by every possible means to prevent or delay the march of the enemy's troops by throwing obstacles in their way and by cutting such lines of communication as they might use.

In order to reach the objective it will therefore be necessary to overcome or destroy obstructions to the movements of troops and to re-establish the continuity of highways and railroads in the most rapid and practical manner.

Troops of all arms may now be actually employed in demolitions during a campaign. Detailed and accurate instructions have, moreover, been furnished all troops upon the methods to be used in the destruction of obstacles by means of explosives or their removal without resort to the latter.

These instructions are, however, peculiar to each arm of the service and include only what is of interest to each. It frequently happens that the commander of a separate party, such as a reconnaissance or an advance guard, has under his orders troops of different arms and encounters obstacles whose destruction requires all the means at his disposal while at the same time he may not have at hand an engineer officer to take charge of placing and firing them.

It is therefore desirable that all officers who may have the command of such detachments should be thoroughly acquainted with the means at his disposal for destroying obstacles as well as the methods of using them, particularly as time is short under

such circumstances and he must act quickly and intelligently.

We have thought it useful, therefore, to gather into a small volume everything relating to demolitions in campaign. While indicating the work peculiar to each arm of the service and taking fully into account the theoretical and practical considerations relating to each, it nevertheless appears indispensable that all officers should know the extent of the coöperation to be expected from other arms or that can be given to engineer troops if any are available.

In other words, it is desired to place all detachment commanders, who may find their progress stopped by an unexpected obstacle, in a position to solve a problem such as the following: given certain tools, explosives, and men and a certain amount of time for the destruction of an obstacle that prevents the advance of the army, what shall be done to obtain the best results?

No hesitation has been felt in going into the subject extensively and while not treating it completely, especially as to the special duties of the engineers, an attempt has been made to give a fair knowledge of all cases that may arise in the field and of the means to be used to overcome them.

THE DESTRUCTION OF OBSTACLES IN CAMPAIGN.

CHAPTER I.

GENERAL REMARKS.

NECESSITY AND OBJECT.

An army in the field often finds it necessary, when in the presence of the enemy, to carry out many demolitions in its own territory as well as that of the enemy.

Indeed, an army may find it necessary—

1. To delay the advance of the enemy by interrupting or partially destroying such lines of communication as he might use.

2. To remove obstacles that interfere with the movement or the fire of its own troops.

3. To avoid leaving in the hands of the enemy either materials or supplies that can not be carried away nor used under the conditions to be found after its withdrawal but that might be of use to the enemy.

LEGITIMACY.

In time of war it is hardly possible to limit the rights of the victor or to discuss the legitimacy of the measures taken by the vanquished for the defense of the country. It is generally admitted, however, that the only permissable demolitions are those required by *military necessities*.

But it is difficult to define accurately the scope of this phrase, of which the interested parties are themselves the judges. It seems, however, that *a priori*, all measures should be excluded that have for their object only the spreading of terror among the people and of making reprisals for defeats or checks that have been suffered.

THINGS SUBJECT TO DEMOLITION.

When acting in good faith, demolitions should be limited to those that harm the belligerents and have a direct relation to a definite operation of war, as was stated above.

From this point of view a study should be made of the methods to be employed for the destruction of highways, railways, all lines of communication, materials that would facilitate the enemy's movements and places, minor defenses, walls and other things that would interfere with the movement of our own troops.

SOURCE OF AUTHORITY.

As the extensive destruction of lines of communication has a considerable influence on the operations of armies from both the strategic and the tactical point of view, it is generally admitted that the only judge of the nature and extent of such demolitions, must be the military commander who alone can be held to account for the resulting consequences. So far as concerns railroads, the rule is absolute that bridges, viaducts and culverts are not to be destroyed or rendered unserviceable without the formal written order of the commander-in-chief of the army or of the generals to whom he has specifically delegated such authority.

The decision in such cases depends much on circumstances and prospective movements—whether it is intended to take the offensive or beat a retreat, etc. Above all, it is always necessary to consider carefully the extent and importance of demolitions both as to their immediate results and as to their possible future effects upon the army causing them.

Indeed, the ill-timed or premature destruction of a highway, railroad, and especially of a bridge, may deprive an army of a valuable means of passage and have extremely serious consequences, resulting, under certain conditions, in cutting off the retreat of many troops (bridge of Lindenau, over the Elster, at the battle of Leipzig). During the war of 1870, there were destroyed precipitately and often without discrimination, many bridges, viaducts and tunnels which, if left intact, would have proved very useful in subsequent operations.

On the contrary, the commander-in-chief who fails to have made in time such demolitions as are necessary, furnishes the enemy with an easier way of reaching him and thus deprives himself sometimes of a chance for success (bridges over the Mozelle above Metz, bridge of Donchery over the Meuse, and the Saverne tunnel, in 1870).

On railroads and highways the destruction of bridges, viaducts and culverts can alone have serious results, and it is necessary that measures preparatory to their demolition should be taken in time of peace if such demolition is to be effective at the opportune moment. As the repair of such structures is difficult and expensive, requiring much time, their destruction in a friendly country should be resorted to only in cases of absolute necessity.

FORMAL ORDERS.

Orders for the destruction of railroads should always state—

1. The exact location, character and extent of the demolition.
2. The minimum time for which the road is to be rendered impassable.

To meet the latter requirement, the officer charged with the duty should seek out such structures upon the line to be cut as will, by their destruction, prevent the re-opening of traffic over the road within the specified time. It is equally essential that these orders shall state the time allowed for making such demolitions, in order that they shall certainly be effected within the desired time.

VALUE OF DEMOLITIONS.

The value of demolitions does not depend solely upon the character of the works destroyed and varies with the local conditions.

Thus, the destruction of a tunnel or an important bridge is of more or less value depending upon the necessity of repairing it in order to re-establish communication and the possibility of passing around it by means of a detour.

The suspension of traffic by the destruction of roadbeds, turnouts, crossings and bridges with a span less than 10 or 12 meters [33 to 39 feet], is usually of short duration.

On the other hand, the destruction of pumps, water pipes, bridges and viaducts of spans greater than 12 meters, high embankments and deep cuts in bad ground, may make necessary extensive repairs, covering time enough to serve one's purpose, and the destruction of unusually long bridges and tunnels may close a road for a very long time.

EXECUTION.

Demolitions may have to be carried on in the presence and under the fire of the enemy or at a distance from him, depending upon circumstances.

In the latter case, the cavalry may be charged with the most urgent demolitions and those that will not permit of delay, particularly during the period of mobilization and upon lines useful to the enemy for concentrating his troops. This may also be the case in the attack of a fortified place in order to cut its lines of communication preliminary to its investment.

Infantry will, in general, be required to carry out only such hasty demolitions as the opening of breaches, the removal of obstacles, the disabling of war material, artillery and railroads and the destruction of telegraph lines and bridges of minor importance.

It is possible also by rapid movements to make demolitions which, while of minor importance, will nevertheless greatly disorganize the transport service and lines of communication in rear of an army. Bicyclists may be advantageously used for work of this character.

Demolitions may therefore be made by troops of all arms, within the limits of the means at their disposal, but those just mentioned, particularly such as are hastily executed, can not be very extensive or of lasting importance in view of the fact that but a small amount of explosive (melinite) is carried by the troops referred to.

But when demolitions of importance are undertaken at a considerable distance from the enemy and in all cases where serious breaks, requiring much work and large quantities of explosives, are to be made in lines of communication, whether at a distance or in the presence and under the fire of the enemy, the work devolves upon engineer troops. Indeed, these troops alone are

equipped with the necessary tools and explosives, and have the training and ability requisite to secure success with certainty under the given conditions and within the desired time.

It is generally preferable to employ technical troops for demolitions whenever such troops are available as the use of explosives, in particular, requires much experience. If they are entrusted to inexperienced men, there is great danger of accidents and of failure, the consequences of which should be avoided as much as possible.

The destruction of tracks and bridges has been re-transferred to the officers of the railroad service, to be accomplished either by the troops of that service or by any others available for the purpose (Art. 54 of the Decree of November 19, 1889).

An order for the demolition of works should in every case be carried out at all hazards, even though it should require a working party that seems entirely out of proportion to the immediate results obtained. Failure to execute rapidly and energetically the order given after the battle of Froeschwiller for blowing up the Arschwiller tunnel, resulted in the railroad line between Strasbourg and Paris not being broken at that point, although a break would have materially increased the difficulty of provisioning the German army from its base. Indeed, the steps taken for the execution of this order were not carried out rapidly enough to prevent the occupation of the tunnel by the Germans before the arrival of the French.

STRUCTURES TO BE DESTROYED.

In a general way, as has been stated above, structures of importance (bridges, tunnels, etc.), are destroyed if serious damage and the longest possible interruption of traffic is desired.

In obstructing highways, cuts should be made at the highest points of embankments and at low places where the cuts can perhaps be flooded, in order to make repairs slower and more difficult.

It is always preferable, in damaging railroads, to select such points as curves, junctions, high embankments, deep cuts, viaducts, tunnels, important stations and, in general, localities where the greatest injury can be done.

Strategical and tactical conditions may, however, be such as to require that lines of communication shall be destroyed only partially and in such a manner as to permit of their restoration in a very short time. In such cases the general rules laid down above should be followed and the extent of the damage should be varied to suit the strategical and tactical conditions that lead to it.

PRELIMINARY STEPS.

Telegraphic communications should be cut before commencing work to prevent the enemy gaining any knowledge of the undertaking.

In operating on railroads, irrespective of the damage to be done, all traffic should be interrupted at a distance of 500 or 600 meters on each side of the selected point by removing a few rails or by stationing men to signal all trains. In all cases the necessary military precautions must be taken to secure the working party from attack.

It seems needless to remark that parties assigned to the work of demolition should be organized with great care both as to personnel and materiel.

PRELIMINARY RECONNAISSANCE.

Whenever necessary or possible, the actual operation should be preceded by a reconnaissance made as carefully as circumstances will permit for the purpose of ascertaining exactly what means, both of men and material, will be required.

By acting too hastily in some cases, particularly in the demolition of bridges, there is danger either of using too large a quantity of explosive or of obtaining incomplete results. It is better, however, to use an overcharge than to take any chance of an undercharge.

It is unnecessary to refer here to the technical examination that should first of all be made of an extensive structure by the officer assigned to its demolition and given a fixed time to carry out the work. In this case the object of the examination is to determine the number and character of the charges to be employed, to locate the chambers for them and to ascertain what means must

be provided to execute the work, taking into account the resources of the locality. It is particularly necessary that this officer should be able to recognize conditions under which the projected work would have no useful result.

Examinations of this character require special training and can properly be made only by engineer officers.

METHODS EMPLOYED.

Demolitions may be made by mechanical means, using ordinary trenching or wrecking tools, but such work requires considerable time for accomplishing any serious damage and can not be done in the presence of the enemy. Resort must therefore be had to explosives for rapid work under fire or in the vicinity of the enemy and with much less exposure of the men engaged.

The general rule is to use ordinary tools always for certain kinds of demolitions. Thus, small trees and telegraph poles should always be felled with the jointed saw. Explosives should be used for felling trees of a diameter greater than .3 meters only when there is not time to do the work with the saw or axe.

Artillery may also be used for demolitions but it is a well established fact that much time and an excessive expenditure of ammunition are necessary to so reduce the accessory works and other obstacles of the defense as to render them incapable of resisting an assault. Moreover, artillery has no appreciable effect upon other works such as heavy masonry bridges.

It sometimes happens that means are not immediately available for such a complete demolition as is desirable. This should not, however, interfere with the execution first of such damage as is possible with the means at hand in order to at least delay the passage of the enemy for some time while bringing up or awaiting the arrival of the facilities for completing the work.

Fire may also be used to destroy harvests, houses and wooden bridges, but it should be resorted to only in special cases and under particular conditions.

Since engineer troops receive thorough theoretical and practical training in carrying out demolitions, the subject will be given consideration more from the point of view of the work of infantry and cavalry.

Nevertheless, it seems useful and necessary to consider in a general way the methods employed by technical troops in order that, should the occasion arise, tactical troops may be able to understand the situation and be in a position to coöperate with the former. Above all we can not recommend too strongly that infantry and cavalry be given practical training in the preliminary operations of those forms of demolition that they will have to execute hastily. Only when men are thoroughly trained in these details, which can be done without expense, and have been repeatedly drilled in the work, can they successfully execute demolitions with the amount of explosive allowed to each corps and that would otherwise be insufficient.

CHAPTER II.

DEMOLITIONS WITHOUT EXPLOSIVES.

I. HIGHWAYS.

When it is necessary to obstruct a highway or road without the use of explosives the end can be accomplished most readily by inundations, abatis, throwing down slopes and destroying bridges.

By *flooding*, when possible, the lower parts of a road an obstacle is obtained of varying importance depending upon local conditions but this obstacle should always be utilized whenever circumstances permit.

When a road passes through a forest or is bordered by large trees, it may be rendered impassable by felling the trees on both sides so that they fall across each other over a considerable distance (several kilometers), care being exercised to leave the trunks of the trees attached to the stumps.

A considerable obstacle may also be produced by barricading a road with heavily loaded wagons and other similar objects that may be collected and confusedly heaped together at a suitable point. The burning of houses along a narrow street that can not be avoided will also cause some delay.

Simple trenches will only cause a temporary interruption of traffic, of perhaps a few hours, unless it has been possible to make them large and numerous before the arrival of the enemy. They should, however, always be made, in default of better obstacles, and if a suitable locality is selected communication may be suspended for a period sufficiently long to permit of bringing up explosives or of carrying out large demolitions in the rear. Interruptions of this character, which can be made with ordinary tools and can be

readily repaired for our own use of the road, can not fail, if frequently repeated, to require some time in repairs by the enemy, particularly as it is often possible to hinder such repairs by our own fire.

Trenches in cuts should be made at the high points of embankments and in low places where they can be flooded. They should be distributed from point to point along the road and are usually from 5 to 10 meters [16 to 32 feet] wide and 3 to 5 meters [10 to 16 feet] deep, the earth being scattered as much as possible in order to increase the difficulty of refilling them. Twenty men provided with picks and shovels can, in five hours, dig a trench 4.5 meters [15 feet] wide at the top and 3 meters [10 feet] deep across a road 8 to 10 meters [26 to 32 feet] wide.

It is evident that much time and work are necessary to accomplish serious damage in this manner and resort should preferably be had to a mine.

When the road is on a hillside, landslides or slips may be produced on each side of the road. The side slopes of deep cuts may be thrown down and the road interrupted for some distance but this method requires much time and is of value only when it is not possible to go around the obstruction.

TIMBER BRIDGES.

Timber bridges may be burned as it will usually require too much time to demolish them. For this purpose petroleum or tar should be sprinkled on the principal truss members or inflammable material should be securely fastened to them or placed upon the flooring, so as to certainly burn the principal wooden members. Fire is moreover, the best means of destroying timber bridges since all the pieces that are reached by the flames are useless for repairs.

OTHER BRIDGES.

Ponton bridges may either be burned by placing inflammable material in the boats, or sunk by loading them with stone after making holes in their bottoms and breaking the roadway, cutting the anchor cables as the bridge sinks.

The cables of suspension bridges may be cut with an axe or cold chisel. Masonry and iron bridges can be destroyed only by explosives.

II. RAILROADS.

METHODS OF DEMOLITION.

If explosives are not at hand or if there is plenty of time, railroads may be obstructed for some hours, and often for several days, by damages that will either cause the wreck of a train or suspend traffic over the line.

Damage may be done either to the track, stations or rolling stock. Damages to the track, especially to important bridges, are the most serious but no sort of damage should be omitted. Demolitions at stations are also of importance as they affect the parts of the track and materiel that are most difficult of replacement. According as more or less time and means are available, the work becomes either a methodical demolition or is confined merely to hastily cutting the line and interrupting traffic.

TOOLS NECESSARY.

In all cases, in addition to the picks and shovels necessary for uncovering the ties, the men should be provided with special tools that may be obtained from the stations or requisitioned from the inhabitants. The most necessary tools for such work are common or monkey wrenches for removing fish-plate bolts; socket wrenches for removing chair bolts; spike-mauls; claw bars; hammers and sledges; cold chisels and axes.

METHODICAL DEMOLITIONS.

Demolitions of this character are of value only when they extend over a considerable length of track and include both lines of a double track road. Moreover, it is generally better to cut the line in two places than to concentrate all the work at one point.

Curves, high embankments, viaducts, tunnels and deep cuts should be selected as the points for destroying the track.

Rails may be torn up in two ways, depending on the system followed in building the road. Switches are destroyed by taking them apart. When the rails are double-headed the wedges are driven out with a hammer and the rail may be forced from the chair by using the claw-bar as a lever. Or preferably, the external jaw of the chair may be broken by striking it with a sledge, perpendicular to the rail, which can then be easily withdrawn.

If the rails are tee-headed the fish-bolts are removed with a wrench or broken with a hammer. A hole is then dug in the ballast to uncover the rail bolts which are then drawn out with the claw-bar or broken off. When this work is completed the rails are lifted out, using one man per linear meter.

If the material can be carried off the enemy is prevented from re-using it and, at the same time, it may be of use to the destroyers.

One hundred fifty men and a train of 25 cars are required for tearing up and loading one kilometer [3280 feet] of track per hour

If the material is not to be removed, the ties are torn up, placed in a pile and burned after the rails have been removed. The rails are rendered useless by heating them over a fire so that they will bend of their own weight or, after heating them, they are thrown down the slope, if the track is on an embankment. They may also be either buried in the ground or sunk under water.

RAPID DEMOLITIONS.

To make a quick cut in a line, a rail is removed from each end of the section to be destroyed and the ballast is removed from the ties. A number of men, placed all on one side of the track, then take hold of the rail and the ends of the ties and turn the section upside down. An embankment should be selected for this work and the track thrown down the slope.

A hasty obstruction may be made by removing the fish-plates from two joints opposite each other and then shifting the two ends of the track laterally in opposite directions. Switches are destroyed by breaking the lighter parts and especially the operating levers and stands.

DERAILMENTS.

For the derailment of a train a point should be selected in a deep cut at a distance from a station. Derailments may be accomplished in various ways.

1. If pressed for time, it will be sufficient to remove the chair wedges or the outside bolts of T rails for a distance of about 50 meters. The same result may be obtained by sawing or cutting in two the cross-ties or by breaking off with a sledge the heads of the spikes for a distance of at least 10 meters. On a tangent

the transverse oscillations of the train may cause the overturning of the rail but it is better to make the derailment certain by spreading the rails

2. The track may be obstructed in a deep cut on a curve, in order to stop a train at night, by heaping up fallen trees, timbers, and masses or large blocks of stone covering a space of at least 3 meters to a depth of about 1 meter.

3. The surest way of causing derailment is to make a false or derailing switch on the main line as shown in Fig. 1, Plate I. To do this the upper layer of ballast is removed from the track for a rail's length and two opposite joints are disconnected in the track upon which the train is expected. The disconnected length of track is then swung out of line laterally about .3 meters [12 inches], pivoting upon the two adjacent joints, and the ballast is replaced in order to leave as little trace as possible of the work.

When the road is double tracked, the party should be acquainted with the directions in which trains are run in order to so locate the work that no disturbance of the parallel track will be noticeable before the train reaches the point of derailment. (Fig 2, Plate I).

4. The removal of a rail may be sufficient and is quick and easy of execution but it is not certain in results on account of the visibility of the break.

5 Mines or fougasses, to be exploded by the passage of the train, may be used.

DEMOLITIONS AT STATIONS.

At *stations* the switches are broken by removing the bolts that secure the levers to the stands and movable rails; the mechanism of signal towers is destroyed; the gearing of turntables is bent or broken; and the essential parts of the water supply are removed or broken.

A *locomotive* may be disabled by breaking or dismantling the feed-water connections and injectors and by disabling the connecting rods and cylinders, bearing in mind that these parts are in duplicate and that both sets should be destroyed. To do more serious damage, the fire box is burned by forcing the fire without filling the boiler or after opening the blow-off valve located under the cylindrical part of the boiler.

To render a *tender* unserviceable the stem of the feed-water valve is removed or broken. It should not be forgotten that each tender is supplied with a set of tools including jackscrews, monkey-wrenches, miscellaneous wrenches for the nuts on connecting rods, cylinders and injectors, sledges, hammers, etc.; and that these tools can be advantageously used for demolitions.

Water tanks and all the appliances used for supplying water to engines, are destroyed as completely as possible, since a railroad is rendered useless when the locomotives can not be supplied with water.

The destruction in railroad yards may be completed by burning the rolling stock that can not be removed, as well as all stores of coal, grease and oil, etc. The burning of stations should not, however, be permitted since no military advantage is gained thereby.

It is, moreover, generally useless to destroy rolling stock. It is sufficient to carry off or destroy the more fragile parts and particularly those parts that are most difficult to replace or assemble.

III. TELEGRAPH LINES.

MEANS EMPLOYED.

Iron nippers, cutting pliers, picks and shovels, are the only tools necessary for the destruction of telegraph lines. At stations the instruments are removed or broken, the batteries are broken and the records, including copies of messages, are seized.

Along the line, wooden poles are felled with an axe or saw, preferably around curves. Iron poles are dug up and thrown down. The wire is then cut with axes or pliers and removed as far as possible. The insulators should also be broken.

If the line is underground, it will usually be found under one of the footpaths or just outside the ends of the cross-ties and at no great depth—1 meter. A few transverse trenches will locate it. The cable is cut with a carpenter's axe as it is of considerable size (Fig. 3, Plate I).

To produce a temporary interruption all the wires may be connected together by another that is grounded in the earth.

This may be very quickly done but it permits of the easy reëstablishment of communication.

IV. ACCESSORY DEFENSES.

NULLIFICATION.

It is sometimes more advantageous to nullify than to destroy certain obstacles, especially those that form accessory defenses such as abatis, sharpened stakes, wire entanglements, military pits, fougasses, etc.

Indeed, the work necessary for their destruction, while very simple, requires considerable time and is very deadly as it must be executed under the rapid and effective fire of the defense. Therefore, it will often be better to overcome such obstacles as sharpened stakes, harrows, abatis, crowsfeet, etc., by covering them with boards, hurdles, fascines, and bundles of straw or grass. It is true that a large quantity of these materials would be required to render passable a zone of such obstacles of any considerable width and length but troops should be trained to use this expeditious method if sufficient means are available for practice.

Fougasses and mines may be passed by on one side or the enemy may be induced to fire them by simulating an attack. If the presence of automatic mines is feared, the ground should be beaten by men with long poles or, better still, a number of animals should be driven over the ground in front.

PALISADES, FRAISES, STOCKADES AND WOODEN FENCES.

Too much time would generally be required to uproot the posts of palisades and various stockades but breaches may be made with sufficient rapidity by breaking down with axes and picks the planking or the posts and crosspieces that support it. Breaches may also be made with saws unless it seems preferable to throw down the posts with bars or ropes after having loosened the earth around their butts.

It is, however, more expeditious to use explosives in all cases.

ABATIS.

After withdrawing the stakes that fasten the abatis together and to the ground, these obstacles may be removed either by hand or with the aid of ropes. A passage may also be made by cutting out the most troublesome branches with axes.

WIRE ENTANGLEMENTS.

The simplest method is to cut the wires with nippers or pliers. They may also be cut with axes and bill-hooks where wrapped around the posts but this method of demolition requires much more time than the former. Good results can not be had by merely uprooting the posts.

The wire must be supported on a block of hard wood if the cutting is to be done with an axe or bill-hook.

CHEVAUX DE FRISE, CROWSFEET, HARROWS, ETC.

Chevaux de frise may simply be disconnected and removed or the pikes may be cut with an axe. Crowsfeet are swept up or gathered by hand.

Ordinary harrows, planks armed with nails and other obstacles of this character are removed after breaking their fastenings with bars, axes, etc.

SHARPENED STAKES AND MILITARY PITS.

As too much time would be required to uproot sharpened stakes with picks and crowbars, it is better to overcome them with a covering of hurdles or hay. They may, however, be cut off with axes or broken down with axes, picks, hammers, etc.

Military pits are made passable by covering them with hurdles, planks, gates, etc. It is, moreover, easy to cross them without any preparation if the artillery has even slightly disturbed the ground where they have been placed.

V. WAR MATERIAL, WALLS, ETC.

WAR MATERIAL.

To disable cannon the breach blocks or their most important parts should be carried off or destroyed. The sights, both on the gun and its carriage, are also destroyed.

A gun may be *spiked* by driving into the vent a conical or pyramidal nail .2 meters long, .1 meter at the large end and .05 meters at the small end. This nail should be driven as far as possible and the two ends then clinched or upset.

WALLS.

Walls may be leveled by the tools ordinarily used for demolitions such as picks, etc. When tools are not available, a wall may be overthrown by using a heavy beam suspended horizontally above the ground from an extemporized gin or tripod composed of three poles lashed together at the top. This forms a kind of battering ram that, when swung perpendicular to the wall, will knock it down. If the wall is not very substantial it may be thrown down by the simultaneous rocking efforts of a number of men, using their right shoulders.

HOUSES.

One of the commonest methods used in war is by fire, using petroleum or other inflammable material. This method is never permitted excepting for isolated houses or groups of houses. The successive demolition of the walls of a house requires too much time.

VI. MISCELLANEOUS APPLIANCES.

DERAILERS.

An Italian inventor, Mr. Pascoli, has devised an appliance that is designed to interrupt traffic on a railroad without destroying the track. This appliance is simply a *derailer* (Fig. 4, Plate II), which, when placed astride upon the head of the rail, furnishes the tread of the wheel an inclined path I and the flange a groove R that carries it gradually towards the outside of the track; that is, in the direction that will not be resisted by the flange of the other wheel on the same axle. The disarrangement of the *derailer* is prevented either by the wooden wedges C or by giving a suitable inclination to one of the legs G so as to support it from one of the cross-ties. The *derailer* of steel has a height above the rail of .1 meters [4 inches], in order to pass under the wheel guards, and weighs 12 kilograms [26.5 lbs.]. It is easily carried in a belt with its wedges.

The setting of the *derailer* can be done so quickly that a man can put it in place immediately before the arrival of the train and thus avoid detection by the track inspectors. Moreover

with the ordinary locomotive headlight, the engineer can not detect the *derailer* at a distance of more than 40 meters, a distance that is insufficient for stopping a train having a speed of even 25 kilometers an hour.

CHAPTER III.

EXPLOSIVES USED IN DEMOLITIONS.

GENERAL PROPERTIES.

Explosive substances have the property of decomposing suddenly from shock or from their reactions upon each other, liberating an enormous quantity of gases at a high temperature.

This phenomenon, which is called *explosion*, results in giving to the gases very high pressures, productive of violent mechanical effects that are used for demolitions in campaign. Such agents have therefore the advantage of developing great explosive powers with a minimum of weight and volume.

EXPLOSIVES IN GENERAL.

Explosive compounds are usually of organic composition and, like the substances composing them, are grouped into two series. the *fatty series* and the *aromatic series.*

The fatty series of organic compounds includes the hydro-carbons, saturated or not, that produce the following explosives, viz:—

Fulminates, gun cottons, nitro-glycerine, dynamites, etc.

The aromatic series, of which the hydro-carbon, benzene, is so to speak, the base, furnishes the explosives picric acid and the picrates (melinite, cresylite, etc.), and the panclastites.

In general, the explosives of the fatty series contain more oxygen than is necessary for the oxidation of their combustible elements while the hydro-carbons of the aromatic series are not saturated, and have always an excess of carbon, making it therefore difficult to be certain of the manner of their decomposition.

QUALITIES OF A GOOD EXPLOSIVE.

The qualities required in a good military explosive are:—

1. Permanence for an almost indefinite period.
2. Safety in manipulation and transportation.
3. Insensibility to shocks, particularly from projectiles.

FULMINATES.

The fulminates may be considered as derivatives of fulminic acid which has not yet been obtained in a separate form but in which the hydrogen is replaced by a metal. There will be considered here only the *fulminate of mercury* which, on account of its being detonated by shock, is used in the manufacture of caps, fuzes and detonators for other explosives, thus permitting the latter to be placed in a resisting envelop.

Fulminate of mercury is too violent in its action and corrodes excessively the metal of receptacles containing it. This explosive is therefore mixed with sulphide of antimony and saltpetre (for rifle caps) or with chlorate of potash (for revolver caps) to moderate its effects.

GUN COTTON.

Gun cotton is obtained by the action of concentrated nitric acid, or by a mixture of nitric and sulphuric acids, on cotton or, in general, upon cellulose such as wood, straw, paper, etc.

It is used for charging all naval torpedoes but its use by the land forces has been abandoned since its handling in large quantities is dangerous on account of its liability to decomposition.

DYNAMITES.

Dynamite is made by mixing nitro-glycerine with silica on some other inert and absorbent material, nitro-glycerine alone being extremely dangerous.

There are two general classes of dynamites, viz:—

1. Dynamites with inert bases, in which the absorbent is pure silica obtained in the vicinity of Radan (Puy-de-Dôme); hence the name, *radanites*, by which they are known.
2. Dynamites with active bases, in which the nitro-glycerine

is mixed with combustible substances that absorb the excess of oxygen and increase the force of the explosion. These explosive bases are charcoal, gunpowder or its derivatives (lithofracteur). gun cotton (explosive or blasting gelatin), etc.

Dynamite is a plastic material, slightly greasy to the touch. and detonates with extreme violence when exploded by a fulminate of mercury fuze. It freezes at moderate temperatures and the nitro-glycerine has a tendency to exude from the base. This tendency is objectionable in that it makes results uncertain but more especially because it leads to accidental explosions with terrible results. For this reason radanite, which was formerly used for military purposes, has been replaced by melinite and is now used commercially only in the form of cartridges.

However, as this explosive can be readily obtained commercially and has practically the same properties as melinite it is possible that it may be levied for use when melinite is not available.

Frozen dynamite is not dangerous so long as it remains in that condition but it is more difficult to detonate. It should not therefore be thawed if it can be used in a frozen state.

MELINITE.

Melinite is obtained as a gelatinous substance, crystallized in irregular cubes, by treating with nitric acid one of the coal tar derivatives.

Its manufacture and manipulation can be carried on without danger and it is insensible to ordinary shocks, friction and atmospheric influences. It can be burned in the open air without danger and when wet is detonated with great difficulty. Melinite most nearly fills the general conditions requisite for demolitions in campaign and is used exclusively in addition to gunpowder.

Melinite detonates *instantaneously* and not progressively throughout its mass. It has therefore an advantage over gunpowder in that it can be used without tamping but when so used it loses an appreciable part of its destructive effect. It is therefore desirable to cover the charge with a small amount of earth or even with a small stone and it rarely happens that there is not time for such a tamping, however hurried, as it will considerably increase the results.

Melinite, as used for demolitions, is supplied in prismatic *pétards* weighing 135 grams and cylindrical *cartridges* weighing 100 grams. These petards and cartridges and the methods of using them are described further on. The artillery also uses melinite for the bursting charges of elongated steel shells, $4\frac{1}{2}$ calibers in length and of large interior capacity, called *torpedo-shells.*

Melinite is used in two forms, viz:—

1. *Granular melinite,* of a light yellow color and detonated by a smaller charge of fulminate of mercury than fuzed or cast melinite. It is used for detonating charges and is itself detonated by a fuze containing 2 grams of fulminate, causing the explosion of the melted melinite within which it is placed.

2. *Fuzed melinite* is slightly more gray in color and is obtained by melting the explosive into a solid, crystalline mass. It has a specific gravity greater than the granular form and an equal weight occupies less space. Moreover, it is easier to manufacture and to load into shells. It is therefore used for the bursting charges of torpedo-shells particularly as the detonating effects of the two forms are equal, weight for weight.

It is known that these torpedo-shells have been so effective against fortifications and shelters protected by earth that it has been necessary to change entirely the design of such works and the methods of defensive siege operations.

CRESYLITE.

Cresylite belongs to the melinite class and is obtained by the action of nitric acid on cresol.

BALISTITE, CORDITE, ETC.

Foreign artillerists use, in place of melinite, various explosives also derived from picric acid and known as *Explosive, type of 1888,* in Germany, *cordite* in England, *ecrasite* in Austria, and *balistite* in Italy. *Ecrasite,* in its latest form, is merely picric acid compressed to a density of 1.4.

PANCLASTITES.

Panclastites result from the action of nitrogen-tetroxide upon hydro-carbons such as carbon disulphide, petroleum and its derivatives, fats and their derivatives, etc.

They are called reaction explosives, since they are prepared only at the moment of use and the reaction of the two substances causes an instantaneous explosion.

VARIETIES EMPLOYED.

Service or black powder was for a long time the only explosive used in the army. In order to obtain greater explosive effects *high explosives* were introduced, first gun cotton, then dynamite and last of all, in France, melinite. The latter is the only mining explosive now used by the land forces.

GUNPOWDERS.

The gunpowder ordinarily used for demolitions is the MC 30 powder formerly used in smooth bore guns, and composed of 75 parts of saltpeter, 12.5 of sulphur, and 12.5 of charcoal.

The combustion of this powder produces a large quantity of gas whose expansion results in combined effects of projection and demolition. Its combustion is progressive and requires an appreciable time for completeness. In order to obtain its maximum effects, a charge must therefor be *tamped*; that is, it must be enclosed by a resisting mass that will permit of the gradual production of the gas in an enclosed space until its full expansive effect is produced.

The effect of gunpowder is small compared to high explosives, particularly if it is not well tamped. When tamped, a charge of gunpowder produces only one-third the effect of high explosives and without tamping the effect is one-twentieth. Untamped powder charges have practically no effect on iron and steel.

Moreover, great care is necessary in the handling of gun powder in order to avoid accidental explosions. All the hammers, funnels and other tools used with it must be made of copper or bronze, to avoid sparks such as are made by blows of iron or steel tools.

It is also necessary to protect gunpowder from all moisture, the least amount of which will damage it.

COMPARATIVE VALUES OF GUNPOWDER AND HIGH EXPLOSIVES.*

Service powders are ignited more readily than high explosives

* This section is a resume of an article published in the *Revue der Cercle militaire* of July 1st, 1899.

but decompose much more slowly and develop much less violent pressures. For this reason they are used in firearms. Moreover, they can be exploded without employing a detonator.

High explosives, on the contrary, require the preliminary action of a detonator but on account of their extremely rapid decomposition and the greater amount of work resulting therefrom, they have a destructive power much greater than black powders.

The difference in the explosive action of melinite and gunpowder may be explained in a general way, by supposing that two charges, one of melinite and the other of gunpowder, are exploded in contact with a resisting metallic partition—a plate of iron, for example.

The very high pressures reached by the gases produced from the detonation of these substances will be greater in the mass of melinite as just stated. These high pressures will cause, the very instant they are produced, a violent rupture of the equilibrium existing between the disengaged gases and the surrounding medium. The gases will by the rapidity of their expansion, be projected against the surrounding objects with an infinitely great velocity. With melinite the blow produced by these enormous velocites will be sufficient to rupture metal plates in contact with the charge but with gunpowder, on the contrary, the useful effect upon the plate is insignificant. The result will be the same in contact with masonry.

In the case of gunpowder, the gaseous masses are merely reflected from the objects they encounter. If, however, instead of exploding the charge of gunpowder in the open air, it is exploded in a closed chamber of exactly its own volume, the result will be entirely different. At each phase of the transformation of the mass of powder into gas, the pressures produced will be added to those already existing and the total pressure will necessarily attain a higher value than in the other case. The kinetic energy thus obtained, acting as a whole upon the material composing the envelop of the charge, is most favorably situated for producing rupture.

It is evident from the preceding remarks that gunpowder can be used to advantage only when it can be placed in mine chambers closed by tamping. Some general information upon this subject will be given further on. Moreover gunpowder is to be

preferred in such cases to high explosives and if, for want of the former it becomes necessary to use melinite, the rapidity of action of the latter may lead to incomplete demolitions, with walls of varying thicknesses, since the explosive effect takes place only on the line of least resistance.

On the other hand, melinite is well suited for the demolition of iron and steel viaducts and bridges, whose members are of such small size as scarcely to permit of the introduction of mine chambers.

CHAPTER IV.

USE OF EXPLOSIVES.

IN GENERAL.

As has been previously stated, high explosives can, as a last resort, be used without tamping and in this lies their great advantage when pressed for time as, for instance, when under fire of the enemy. This method of using them is employed only against objects that offer slight resistance and it is preferable in all cases to use a tamping, however light. The fact that gunpowder is damaged by moisture should not be overlooked.

Whenever charges are placed underground or within strongly resisting materials, and particularly when gunpowder is used, it is absolutely necessary to follow certain special methods that are usually the functions of engineer troops but that should be known in a general way to all officers.

MINES.

Any charge of explosives that by its ignition produces destructive effects injurious to the enemy is called a *mine*. This charge is placed in a space prepared for the purpose and called a *mine chamber*. When the charge is in place it is known as a *charged mine*.

SYSTEMS OF MINES.

When several mines are intended to produce one general result as, for instance, the destruction of a large bridge, the entire work is called a *system of mines*.

The underground communications that must be excavated to reach the mine chambers are called *galleries*, if of large or medium

size, and *branches* or *branch galleries* when of small dimensions. Vertical connections are called *shafts* when large enough for the passage of a man and *wells* or *drill holes*, when a man can not pass through them.

Galleries, branches and shafts are lined with a sheathing of planks supported at intervals of a meter by *gallery frames*. In rock and in some very stiff earths galleries and shafts of small dimensions may be excavated without sheathing.

PERMANENT SYSTEMS.

The demolition of large masonry structures (bridges, viaducts and tunnels) is accomplished by means of a permanent system of mines prepared in time of peace. These systems consist of chambers placed in the interior of the masonry (piers and abutments) of bridges and viaducts and above the arch or behind the side walls of tunnels. Gunpowder is universally used for such demolitions.

EFFECT OF MINES.

The deflagration of a charge of explosives placed below ground that has a horizontal surface produces:—

1. *Interior Effects*, consisting first of a violent compression of the ground in the vicinity of the charge and the formation of a spherical space called the *chamber of compression*. In addition to this, the expansion of the gases produces a concussion whose destructive effects upon structures in the ground or in contact with it extend to some distance.

2. *Exterior effects*, with a full charge, are the projection of the earth upward in the form of a cone and the formation of a *crater*, more or less refilled by the earth. The mound around the edge of the crater is the rim or lip.

CALCULATION OF CHARGES.

The charge for a mine depends upon the effect that is desired and the material in which the mine is placed.

The line of least resistance (L L R), is the distance from the center of the powder O, (the mine chamber), to the nearest point on the surface, A (Fig. 5, Plate I). It is ordinarily represented by *h*.

When AB or r, the radius of the crater as measured at the surface of the ground, is equal to h the mine is called a *common mine*. The mine is *overcharged* when r is greater than h and *undercharged*, when r is less than h. If the mine produces no exterior result, that is, if r is equal to zero, it is called a *camouflet*. The mine constant or index is designated by n and represented by the formula $n=\frac{r}{h}$.

The powder charge for a common mine is calculated from the formula $C=g\,h^3$, in which C is the weight of the charge in kilograms, h is the line of least resistance in meters and g is a coefficient whose value varies with the character of the material in which the mine is located.

The principal values of g are 1.5 for ordinary earth, 2 for earth mixed with *gravel*, 3 for common masonry and 4 for the heaviest and best masonry. *

The above formula is known as the *miner's rule*. For overcharged or undercharged mines the formula generally used is $C=gh^3\,(\sqrt{1+n^2}-.41)^3$, in which n is the mine index or constant.

EFFECTS OF MELINITE.

As has just been stated, gunpowder is really effective and susceptible of useful employment only when well tamped. On the other hand, the decomposition of a charge of melinite takes place instantly thoughout its entire mass. There is formed immediately a large amount of gas under enormous pressure. The air surrounding the charge can not be displaced with sufficient rapidity to open a passage to this gas and acts therefore so much in the same way as tamping that the latter is no longer indispensable.

Melinite may therefore be used in contact with hard bodies which it either destroys or reduces to fragments. *Contact* is indispensable but *tamping* is not, although the latter increases the effect when of even the lightest character. For this reason melinite is generally used for demolitions in campaign although gunpowder is to be preferred from the point of view of economy.

* In the formula $C=g\,h^3$, if C represents the charge in *pounds* and h the line of least resistance in *feet*, the values of g become .31 for ordinary earth, .41 for clayey gravel, .62 for common masonry and .82 for the best masonry.—Translator.

It may also be used to charge mines and its effect is similar to that of gunpowder but is three times as great for charges of equal weight.

The same interior and exterior effects are produced. Moreover, the detonation of melinite in the open air produces a heavy concussion that extends to great distances and the violent expansion of the gas in an inclosure may occasion serious destruction. This action is known as the *blast* of melinite and must be considered in permanent fortifications.

DRILLED OR BORED MINES.

Drilled or bored mines are cylindrical holes of various diameters according to the tools used. An explosive charge is placed at the lower end, either in the hole itself or in an enlarged chamber.

Drilled mines of small diameter may be of great service, especially with the aid of Major Binet's mine drill .06 meters [2.36 inches] in diameter. This tool (Fig. 6, Plate III), is composed of a steel drill point that is cross shaped for firm soils and has a conical point for loamy material. The drill points are fitted to a drill head into which are screwed, one above the other, hollow extension rods of steel 1 meter [39.37 inches] long and fitted with screw couplings.

The tool is used in the same way as an ordinary mine drill, giving it at the same time a slow motion of rotation. In clayey soils holes may be driven easily to a depth of 12 to 15 meters [40 to 50 feet] at a rate of 5 to 8 meters [16 to 26 feet] an hour. Under very favorable conditions this rate may be 1 meter in two minutes.

A chamber may be made at the end of the hole by inserting several melinite cartridges attached to the end of a small rod and exploding them to form a chamber of compression. If, instead of placing this charge of melinite at the end of the rod, it is extended over a part of the hole vertically, an elongated chamber is formed or even a shaft, if the charge extends to the surface.

The mine is charged by pouring granular powder directly into it if the slope of the hole is greater than 1 to 1. If the hole has a flat slope, a brass tube is inserted and through it are forced

a number of powder or melinite cartridges not greater than .03 meters [1.18 inches] in diameter, using a jointed brass rammer. When the hole slopes upward a rammer with a head of the same diameter as the interior of the brass tube is used. The detonation of the charge is generally produced by a melinite cartridge placed in position by the rammer whose head has a groove to accommodate the fuze wires. Tamping is, in general, unnecessary.

It is evident that mine chambers can be very rapidly obtained in this way, since a kilogram [2.2 lbs.] of melinite will make a chamber large enough to contain 850 kilograms [1870 lbs.]. An embankment can thus be destroyed in a few minutes so as to cut a highway or railroad. In the same way bridge abutments, tunnels and houses may be destroyed very rapidly by placing one or two charges in the abutments, arches or foundations.

Drilled mines can be frequently and advantageously used in demolitions and it is to be regretted that they require a special tool. Infantry and cavalry pioneers should be instructed in the use of the Binet drill in time of peace, since it may be improvised from the tubular iron used for gas pipes or for railings and the ordinary couplings of commerce.

It is also practicable to improvise in this way lines of fougasses in front of field works, making such suitable arrangements as will fire them at the proper time.

No consideration is given here to drilled mines of large diameter whose execution requires special arrangements and very unusual tools. Only engineer troops can carry out such work.

BLASTING.

Blasting is used for breaking up stone when the work can not be done in the better way with the aid of quarrying tools.

The charges are placed in small holes drilled in the stone or masonry and of a diameter not exceeding 2 to 5 centimeters [.8 to 2 inches], the holes being made either with percussion or rotary drills.

For percussion drilling an ordinary miner's drill is used and is rotated from $\frac{1}{5}$ to $\frac{1}{10}$ of a turn by one or two men after each blow upon the head of the tool. The use of water in the hole facilitates the work. Such holes may be drilled at the rate of from

.1 to .5 meters [4 to 20 inches] an hour, depending upon the hardness of the stone.

In semicompact stone of medium hardness the rotary method is employed, using an earth borer pushed ahead by the breast of the workman or by a jackscrew.

A preliminary charge of dynamite will make a chamber large enough to receive a melinite charge six times as great.

The hole is charged after it has reached a suitable depth and been well cleaned out. The charge should occupy $\frac{1}{3}$ or $\frac{1}{4}$ the depth of the hole if gunpowder is used and $\frac{1}{4}$ to $\frac{1}{5}$ for melinite. Melinite should preferably be used in wet holes.

Tamping should be done with packed earth or sand for powder charges and with water or, better still, with sand for charges of melinite.

For large and important blasts it is necessary to employ special tools that are called *drilling* or *boring machines* and can not be used in campaign.

METHODS OF IGNITION.

KINDS OF CHARGES.

Charges may be either concentrated or elongated. *Concentrated* charges are used in underground mines and in all cases when it is desired to produce an effect uniformly in all directions.

Charges are considered as *elongated* only when they have a length at least 4 or 5 times the diameter of a circle equal to their cross sections.

Concentrated charges are generally employed and, when gunpowder is used, they are placed in cubical boxes or in chambers whose shape is as nearly cubical as the conditions of the work will permit. Elongated charges are made up of cartridges, enclosed in tarred sand bags, that are placed in the recess prepared for them.

ARRANGEMENT OF CHARGES.

Melinite charges, either concentrated or elongated, are ordinarily made up of model 1886 petards or the model 1890 cartridges that have been described previously. In preparing concentrated

charges the petards or cartridges are brought into close contact with each other and made up by straps or any other kind of lashing into packages or bundles that should be as nearly as possible the shape of a cube. The petards or cartridges may also be enclosed in a canvas or cloth sack. In elongated charges the petards or cartridges are placed end to end, either singly or in small bundles, depending upon the weight of the charge per linear meter. In fact, the successive parts of these charges may be placed in cloth or wooden tubes, lengthwise on small rods, in troughs or merely in the hole made in the body to be destroyed. Care should be taken to place this work in the hands of men specially trained for it in order to avoid the breaking up to which such charges are liable.

A charge composed of petards should always be made up in such a way that the faces of the petards are in contact and it should be remembered that the maximum effect is produced when the relation of the length to each of the other dimensions is as 5 to 1. Petards placed in contact with an object to be demolished, should be applied as closely to it as is possible.

FIRING DEVICES.

Explosive charges may be ignited either by pyrotechnic compositions or by electricity.

PYROTECHNIC METHODS.

Under this method ignition is brought about by pyrotechnic compositions that are of slow or rapid combustion.

When gunpowder composes the charge the composition ignites the powder directly, but when the charge is of melinite the composition explodes a *fuze* that detonates by simple ignition and thus detonates the charge of melinite in contact with it.

The *fuze* or *detonator* is a brass tube closed at one end (Fig. 7, Plate III). It is 45 millimeters [1.77 inches] long, 6 millimeters [.24 inches] in diameter and contains 1.5 grams [23.14 grains] of pure fulminate of mercury. The charge is held in place by a small brass cap with a small central opening that is closed with a drop of varnish to protect the fulminate from moisture. The part of the tube that contains the fulminate is shown on the outside by a coat of black paint.

SLOW FUZES.

The only fuze of this kind that is provided for in departmental instructions is the *slow fuze* or *Bickford safety fuze*, a commercial article. This fuze consists of a cord composed of two layers of tarred thread wound spirally one upon the other but in contrary directions, in the center of which is formed a tubular opening 3 millimeters [.12 inch] in diameter, filled with fine powder well compressed into a continuous core [Fig. 8, Plate III]. Its external diameter is 5 millimeters [.2 inch].

It burns at the rate of 1 meter in 90 seconds. Its length is made sufficient to enable the operator to retire to a safe distance. Generally 1 meter is ample for this purpose since it is possible to run 200 meters before the fuze burns out.

When the fuze is to remain for some time in the ground or under water a *submarine* fuze is used that differs from the ordinary Bickford fuze only in the addition of a rubber envelope or a covering of waterproof varnish.

Ignition of Bickford fuzes.—To easily light the Bickford fuze the end should be cut on a bevel or should be split and the two halves separated without letting the powder fall out. To the powder, thus laid bare, is then applied a piece of lighted tinder or coal, a lighted cigar, etc.

Igniters.—If the contact of the igniting body with the powder of the Bickford fuze is not good, ignition will not take place. This difficulty is avoided by using the Bickford portfire or tinder.

The *Bickford portfire* consists of a cylinder, 4 to 5 millimeters in diameter, of thin blotting paper tightly rolled and steeped in a solution of acetate of lead. It burns at the rate of about a centimeter [.4 inch] per minute.

Tinder is a braided cotton cord impregnated with chromate of lead. It burns at the rate of .4 meters [15.75 inches] per hour.

It is better, however, to use the *Ruggieri fuze* or igniter (Fig. 9, Plate III) which is placed over the square-cut end of the Bickford fuze. This igniter is formed of a small copper cap containing a combustible composition that is traversed by a piece of quick match. The latter extends outside the cap and is easily lighted.

QUICK FUZES.

The only quick fuze actually authorized is the *detonating fuze.*

This fuze is composed of a core of granular melinite contained in a pewter envelope (Fig. 10, Plate IV). It has the form of a tube whose external diameter is 5.5 millimeters [.22 inch] and corresponds to the internal diameter of the detonator used with melinite petards. It weighs about 100 grams per linear meter [.2 lb. per linear yard] and is pliable to such an extent that it may be bent in any direction, care being taken in all cases not to twist it too violently or abruptly.

This fuze can only with great difficulty be ignited by contact with a lighted body and its combustion ceases without producing the explosion of the detonating fuze.

To detonate it, the fuze is cut square, so as to lay bare the dry part of the melinite core, and the end is then capped with a fulminate of mercury detonator. The black portion of this detonator is secured against the black portion of a second detonator that is primed with Bickford fuze (Fig. 11, Plate IV). This black portion indicates the length occupied by the fulminate.

The detonating fuze may also be fired by the explosion of a melinite petard. In this case care must be taken to secure the end of the fuze to the petard along the full length of the latter

The *rate of detonation* of this fuze is about 2000 meters per second and it may therefore be considered as instantaneous

To prime a melinite petard with the detonating fuze the end of the latter is inserted in the fuze chamber and secured in place by a lashing of twine. To produce the explosion of several petards placed in a row but at a distance from each other, the first is primed and then each petard is connected with the following one by a detonating fuze that is lashed for the full length of the first and is inserted to the bottom of the fuze chamber of the second.

To produce the simultaneous explosion of several mines, grouped in any way, they should all be prepared with detonating fuzes, whose lengths need not be measured on account of the rapidity of detonation of this type of fuze. At the desired time the free ends of the fuzes are brought together and fired.

Great care must be exercised to prevent detonating fuzes crossing

each other or forming loops at a distance less than .2 meters [8 inches] since the explosion of the first strand will cut the second at the point of intersection and the detonation will not be transmitted further.

The same thing will happen in case the fuze A B D is bent back upon itself in the neighborhood of two detonators A (Fig. 12, Plate IV) joining this fuze to a Bickford or to a detonating fuze A G designed to transmit the explosion to B D. The explosion will be stopped at the point D which will be cut by the explosion of the fuzes A.

Instantaneous Fuze.—Mention should be made of the quick fuze that was in use previous to the detonating fuze and known as the *instantaneous fuze.*

This fuze is composed of three strands of quick match bound together by a strip of waxed linen, the waxed side inside, and covered with a helical wrapping. Outside of the latter is a layer of natural rubber and, finally, a braided covering. Its rate of combustion is 100 meters [390 feet] per second.

Powder Hose and Powder Train.—When other fuzes can not be had these primitive means may be employed. The *powder hose* is a linen tube 15 to 25 millimeters [.6 to 1 inch] in diameter and filled with powder. It burns at the rate of 3.5 meters [11.5 feet] in the open air and 8.5 meters [28 feet] in a hose trough. A *train of powder* placed upon a board burns at the rate of 2.5 meters [8 feet] per second.

DISADVANTAGES.

All the preceding pyrotechnic methods have the disadvantage of producing smoke in the galleries and of not causing an instantaneous explosion. When they are used it is therefore necessary to wait a considerable length of time after the fuze has been lighted before the mine can be entered either to allow the smoke to escape or to seek the cause of a misfire.

ELECTRICAL METHODS.

GENERAL PRINCIPLES.

When possible to do so it is always better to ignite explosives of all kinds by means of an electric current that is passed through a special fuze placed in contact with the explosive.

The electrical method requires the installation of conductors connected at one end to the source of electricity and at the other to the fuze. These conductors are iron or copper wires of sufficient size to resist the earth pressures arising from nearby explosions.

The *lead wires* are placed in the main gallery and are connected with the source of electricity. They are also connected, at the proper time, to the *branch wires* or to the special wires of any mine.

When the electrical method is employed to fire melinite it is necessary to make the same arrangements for the connection of the petards to the fuzes, as have been previously described for fulminate of mercury fuzes.

There are two kinds of electrical fuzes; high tension fuzes and low tension or quantity fuzes. *High tension fuzes* are based upon the principle that if conductors, perfectly insulated from each other, have their ends brought near enough together a spark will be produced between them when a high tension current is passed through the conductors. These fuzes (Abel, Ebner, etc.) are used industrially but have not been adopted in either the army or the navy. They will not be described further. *Low tension fuzes* are exclusively used and are based upon the fact that if the two conductors are connected to a source of electricity of low tension but of sufficient quantity, the passage of the current through the platinum wire heats it to incandescence and causes it to ignite a sensitive substance such as gun cotton.

Electric Fuze.—The only electric fuze that is emplo ed, is composed (Fig. 13, Plate IV) of two copper wires connected by a very fine platinum wire of helical form that is reddened by the passage of the electric current and ignites a small plug of gun cotton with which it is in contact. The insulation of the copper wires is secured by imbedding them in a hard wood plug *b* surmounted by a paper tube *d* in which is placed the gun cotton *c*. Finally, a detonating primer *e* of fulminate of mercury is added. The whole plug is given a coating of Chatterton waterproofing compound to render it impervious to moisture.

FIRING APPLIANCES.

The current for raising the platinum wire to a red heat may be obtained either from induction machines or primary batteries.

The *Breguet Exploder*, known as the blow-with-the-fist machine, is the most widely used of the induction machines. Besides being very simple and essentially portable it has also the advantage of requiring no liquid (Fig. 14, Plate V). It utilizes the induced current formed by the sudden withdrawal and replacement of the armature of a powerful magnet. To fire a charge, the two conductors are connected to the terminals of the machine, the safety catch is withdrawn and, at a given signal, it is only necessary to strike a blow with the hand upon the spring handle.

Siemens and Halske have designed, for military use, an *exploder* that produces tension effects (sparks) instead of the quantity effects (incandescence of platinum wire) given by their ordinary machine. The wire in the coils is rearranged and the current passes through the exterior circuit, of which the fuze is a part, only when the circuit is broken by the movement of a cam (Fig. 15, Plate VI).

For a long time the *bichromate* or *plunge battery* was used in the engineer service to produce electric sparks. It is composed of a cylindrical exterior cell of gutta-percha and a cylinder *B* of the same material, called the plunging cylinder or merely, the plunger (Fig. 16, Plate VI). The latter has on its upper end a copper ring A for handling and two copper binding posts *b b* that form the positive and negative poles. Four cylindrial chambers open upwards from the base, each of them being lined with a sheet of amalgamated zinc to within 10 millimeters [.4 inch] of its orifice and containing, in addition, a rod of carbon placed axially. These four zinc-carbon elements are rigidly attached to the inside of the plunger. The exciting liquid commonly used is a mixture of four parts of chloro-chromate of potassium (yellow salt) and ten parts of bi-sulphate of potassium (white salt) dissolved in 120 parts of water.

To bring about the explosion, the conductors (attached to the wires of the electric fuze) are connected to the two poles *b b* of the battery plunger and the latter is plunged into the exterior cell containing the exciting liquid. The contact produces it.

These cells have been replaced by an induction machine of easy manipulation that is called the *Boulanger exploder* and furnishes high tension currents. This exploder is a magneto-electric machine composed of an induction coil that revolves about a vertical axis and between two pole pieces attached to electro-

magnets. The coil is rotated by pulling on a cord that has previously been wound around the axis of the coil. The cord should be drawn out at only a moderate speed in order to avoid the danger of burning out the platinum fuze wire and thus causing a misfire.

The old bichromate battery will fire one fuze to distances as great as 900 meters or two fuzes at a distance of about 400 meters. The range of the Boulanger exploder is slightly less and is only 300 meters for two fuzes.

USE OF VARIOUS FIRING MACHINES.

In campaign, where it is always necessary to work rapidly and with little preparation, it is scarcely possible to use machines other than those producing *high tension* electricity, such as the Breguet exploder, the Siemens machine, the bichromate battery and the Boulanger exploder. These appliances are light, strong and always ready for use and obviate the necessity for devoting great attention to the perfection of contacts and the distance from which the mine is to be fired.

With all *low tension* appliances (various primary batteries, the Ladd, Siemens, Gramme machines, etc), the firing arrangements must be prepared long enough in advance to permit always of being certain that the circuits and fuzes are in working order. Further than this, the conductors need not be insulated.

THE PRIMING OF VARIOUS EXPLOSIVES.

Principle.—Priming consists in adding to explosive charges the means of ignition or explosion. It is the first step in the preparation for firing.

Gunpowder.—Priming with pyrotechnic methods is done only with the Bickford safety fuze. The end of the fuze is trimmed and introduced into the charge through the side of the powder box or into the receptacle containing the priming charge. This end is held in place in the charge by means of a pin or lashing to prevent its being withdrawn by any accidental strain on the fuze.

To obtain the simultaneous explosion of several charges by means of the quick fuze or match, resort must be had to what is called the *equalization of fuzes.* This operation consists in so determining and regulating the initial point of the fuzes that the

lengths necessary to reach all of the mines shall be the same.

The use of the detonating fuze has done away with the equalization of fuzes. It is only necessary to place one end of this fuze in the charge with the same precautions as for the quick match, it being assumed that the charge is contained in a receptacle of sufficient strength, such as a box, cloth bag, card board cartridge case, etc.

Priming, when electric methods are used, is effected by connecting up the ends of the secondary wires of a fuze that has been placed either in the powder box, cartridge, powder bag or priming box. This method of priming permits of firing exactly at the desired moment.

Melinite.—To explode a whole charge of melinite it is only necessary to detonate one of the petards composing it. This petard is called the *primer* and may be detonated by either pyrotechnic or electric methods.

Pyrotechnic priming may be done with either the slow fuze or the detonating fuze, according as it is desired to fire from nearby or from a distance.

Priming a Detonator.—A detonator is primed by inserting within the tube an end of slow fuze that has been cut square and well cleaned. The slow fuze is pushed into good contact with the fulminate and the edge of the detonator is compressed with a pair of pliers so as to hold the fuze in place without choking it.

Priming a Melinite Petard.—To prime a melinite petard, the wire strip is removed and consequently the pewter cover so as to expose the fuze chamber, into which is thrust the tube of a detonator. Care must be exercised not to suspend the petard by the fuze as it is indispensable that the detonator remain firmly in place at the bottom of the fuze chamber.

It is possible that the reaction of the detonator may force it from its chamber at the instant of detonation and it is therefore desirable to secure it to the petard by a lashing as shown in Fig. 17, Plate VI, or to maintain it in its place in the chamber by a small wedge pressed in gently and without the use of force.

Priming with the detonating fuze is executed in the same way as with the slow fuze. The use of a detonator with this fuze is not, however, absolutely necessary. The explosion of a detonating fuze, whose end has been pushed home to the bottom of the detonator chamber of a petard is sufficient to initiate the detonation of

the latter. The same result can generally be accomplished by merely applying the detonating fuze to the exterior of the petard in the direction of the greatest length of the latter and by firmly lashing it in place.

The *electric priming* of a melinite charge is secured by attaching the electric fuze to the end of the cables leading to the exploder, using the wires connected to each cable. The fuze is then placed in the priming petard or cartridge and the latter is firmly secured to one of the charges of explosives.

Charges of Several Petards.—The explosion of a charge composed of any number of petards is always assured by the detonation of a single primed petard. Nevertheless, when the charge is large, for greater certainty, there is no disadvantage in priming two or three petards that are fired simultaneously. In this way the chances of a misfire in a fuze are decreased.

When the charge is an elongated one, either one of the end petards may be primed. If there are several rows of petards in juxtaposition, the end petard of one of the rows is primed. One of the outside petards of a concentrated charge is also primed, preferably the petard farthest from the obstacle to be demolished.

If it is desired to explode simultaneously several concentrated charges only a short distance apart, they should be connected by rows of petards placed end to end without a break anywhere. A single primed petard, placed in one of the outside charges, will be sufficient to detonate all of them but, as has been remarked previously, it is better to prime several petards.

The Importance of Priming and Connections.—The following quotation is from the *Revue de Cercle militaire* of July 8, 1899:

"Priming and connections play an important part in the preparation of mines since upon their good working order depends simultaneousness of action and, therefore, the maximum efficiency of a system of charges. The partial demolition resulting from misfires must often be completed by the installation of new charges to replace those that have not ignited and have been dislodged or thrown out by the explosion.

"Such failures cause delays and losses of time and they may, above all, result in preventing the attainment of the desired end in the allotted time. It is important, therefore, to absolutely avoid them. To this end, the proper execution of all the arrange-

ments for firing, and particularly the security of all joints, should be examined carefully. These joints serve to connect the metallic parts of the lines and are likely to cause trouble whenever used in primings and lead wires.

"Such difficulties can be overcome by the employment of competent men for the direction, superintendence and execution of the work."

USE OF MELINITE.

SUPPLY.

Infantry and Cavalry.—Since infantry and cavalry are obliged at times to remove certain obstacles without resorting to tools, whose use requires a considerable time and offers great difficulties under the fire of the enemy, they are provided in the field with a supply of explosives in whose use the pioneers of these two arms are trained in time of peace. Indeed, each corps has allotted to it a fixed quantity of melinite petards, detonators and money with which these pioneers execute a number of demolitions.

Melinite has the same destructive power, weight for weight, as dynamite but, being of greater density, it produces greater effect for equal volumes. Moreover, melinite is devoid of the greater part of the disadvantages of dynamite. It does not freeze and is detonated by shock only when the latter is very violent; it is very rarely exploded by the impact of rifle balls and when this does occur, the detonation does not spread. This insensibility to shock greatly facilitates the use of melinite in actual work. Melinite petards can be bent by striking them with a hammer and can thus be made to conform to the shape of the surface to which they are to be applied. They can also be nailed to the pieces of timber that are to be destroyed.

The *field supply* of melinite for infantry (108 petards [32.4 lbs.] and 48 detonators to a regiment) is insignificant in amount.

The replenishment of the supply of explosives for infantry is provided by the artillery service from its reserve supply, distributed between the ammunition column and the artillery park of the army corps.

In the *cavalry* every man carries a melinite petard in the pocket provided for it in the saddle bag. The boxes of detonators

are distributed among the sergeants, corporals and pioneers. There are two Bickford safety fuzes per box. The supply of melinite provided for cavalry regiments, active and reserve, is therefore as follows:—

CORPS CAVALRY REGIMENTS.

Squadrons with the colors	600 petards	200	detonators.
" in the reserves	600 "	200	"
Depot - - -	300 "	100	"
Total - - -	1500 petards	500	detonators

INDEPENDENT CAVALRY REGIMENTS.

Squadrons with the colors	600 petards	200	detonators.
6th squadron, if there be one	150 "	50	"
Depot - - -	300 "	100	"
Total - - - -	1050 petards	350	detonators.

[One petard contains .3 lbs. of melinite.—Translator].

Moreover, with each independent division of cavalry there is an ammunition wagon that carries 800 detonators, 720 fulminate fuzes, 720 Ruggieri igniters, 10 cases of melinite petards containing 150 petards of 135 grams each, or 200 kilograms [440 lbs] of melinite, and 800 meters of Bickford safety fuze.

It is therefore evident that in the infantry and cavalry it is necessary to be economical in the use of melinite since the total supply available for them may be expended in a single demolition of any considerable importance. It is also evidently necessary to reserve it for use under pressing conditions and particularly for the destruction of iron or steel.

Engineers.—Engineer companies are each supplied with 70 kilograms [154 lbs.] of melinite in four ammunition packs. Each company of railroad pioneers has an ammunition wagon with 380 kilograms [836 lbs]. The engineer train of an army corps has a similar ammunition wagon and there are three of them in the general army train. These supplies are sufficient for the execution of large demolitions since it is rarely necessary to use heavy charges.

MELINITE PETARDS.

The *melinite petard, model of 1886*, consists of a brass case of prismatic form and about .15, .03 and .02 meters [4.9, 1.2 and .8 inches] on the three sides, in round numbers. It contains 135 grams [.3 lbs.] of melinite. The larger part of this is fuzed melinite but the portion around the detonator chamber is granular melinite which alone can be detonated by the service detonator.

To the lid or cap is soldered a small tube, called the *detonator chamber* (Fig. 18, Plate VI), that projects into the interior of the case and is designed to receive the detonator to explode the petard. Its orifice is closed by a strip of wire that is removed at the time the detonator is inserted. The lid or cap is covered by a guard of pewter.

The melinite petard of 135 grams has the same dimensions as the old petard containing 100 grams of dynamite.

MELINITE CARTRIDGES.

The *cartridge, model of 1890*, containing about 100 grams [.22 lb.] of melinite, is used only by the engineer service. Its general arrangement is the same as that of the petard excepting that it is cylindrical in form and that it is .13 meters [5.12 inches] long by .03 meters [1.2 inches] in diameter.

Since the cases containing melinite are waterproof it is not necessary to take the same precautions against moisture as in the case of charges of gunpowder.

Resort may also be had to petards containing 1 kilogram [2.2 lbs.] which are to be found in the supplies of fortified places. They are contained in cases made of brass or of waterproof paper.

DETONATION OF A PETARD.

To summarize, in order to detonate a petard with the slow fuze it is necessary:—

1. To prime the petard, that is, to place the detonator as described above.

2. To prime the detonator by thrusting into the latter one end, cut square and well cleaned, of the slow fuze as has also been described above.

3. If a Ruggieri igniter is available, place it upon the other end of the fuze, which should also be cut square.

To simplify the work, the detonators provided with the field supplies are prepared with their fuzes and igniters. The igniter may be lighted, as in the case of the Bickford fuze, by a piece of tinder, a smoker's fuzee or even by an ordinary match. The lighting should be entrusted to a cool-headed man who will do it deliberately, at the given signal, and will observe all of the precautions prescribed for assuring its efficacy. He should retire to a distance as soon as he hears the hissing that occurs when the Bickford fuze begins to burn, placing the free end of the fuze on the ground carefully in order not to disarrange the priming.

To make a double ignition, take in the left hand the igniters of the two detonators and light them. By holding in the left hand the igniters of several detonators, a number of charges may be fired at the same time.

In order to avoid all possibility of accidents, it is necessary to withdraw to a distance of at least 150 meters from the object to be destroyed. It has been stated above that a length of 1 meter of Bickford fuze will allow a man to retire to that distance at an accelerated pace.

When the charge consists of a single petard, care should be taken to apply the largest face (.15 meters by .03 meters) of the petard as closely as possible in contact with object to be destroyed.

Practically simultaneous explosions of several charges may be obtained by making the Bickford fuzes of equal lengths. This is called the equalization of fuzes, as stated previously.

But, to obtain that absolute simultaneousness which is often indispensable when several charges are intended to unite in the production of a common result, or to avoid the use of excessive lengths of Bickford fuze, resort must be had to the detonating fuze that is supplied only to the engineers.

It is not intended to go into the details of the use of explosives by engineer troops since that arm receives full instruction on the subject. It does, however, appear obligatory to enter into all of the developments of the subject that are of interest to the infantry and cavalry.

USE OF VARIOUS EXPLOSIVES.

Dynamite and Gun Cotton.—Infantry and other arms may make use of various explosives (dynamite and gun cotton) in exceptional

cases and when melinite petards are not available. The charge to be used in each particular case is determined by assuming that these explosives may be substituted for melinite, weight for weight.

All of the instructions given for melinite in connection with priming, the preparation and placing of charges, their ignition and the precautions necessary to avoid accidents, are applicable to these explosives.

Gunpowder.—The use of gunpowder in demolitions is the exclusive function of engineer troops. The general information already given in connection with this subject makes it evident, indeed, that the management of this explosive and its preparation for action under varying conditions, require instruction and experience that can not be made available to all arms.

CHAPTER V.

EXECUTION OF DEMOLITIONS WITH EXPLOSIVES.

MEANS TO BE EMPLOYED IN PARTICULAR INSTANCES.

THE following instructions relate to the application of the preceding general rules to particular cases and are intended to permit the complete solution of the question as to the most practical and exact method to be followed in any particular instance.

Circumstances may, however, be such as to require that demolitions be made under the fire of the enemy or when all the means necessary for the work are not available. In such cases, substitutes must be used for the supplies that are wanting and the simplest and quickest methods must be employed in placing charges. Thus, when the charges must be suspended, arrangements should be made in advance for hanging them up by means of heavy wire hooks, or for sustaining them on supports to which they have been previously secured or for attaching them by means of lashings.

In such cases it is nearly always desirable to ignite each charge separately in order to avoid the disadvantages resulting from misfires and from the exposure when the operation lasts too long.

Improvised methods vary with the conditions of the case and require considerable experience that can only be acquired by study and practice.

LOOPHOLES.

A charge of four petards, suspended against a wall of average thickness will make an excellent loophole when detonated. In making a breach or loophole it is necessary to withdraw, after lighting the fuze, to a distance of only 50 meters along the face of the wall in order to be out of danger from the explosion.

This method is expeditious but when any considerable number of loopholes is to be made it requires too large a quantity of melinite.

WALLS AND ARCHES.

The charges to be used to make a breach in or to throw down a wall will depend upon whether the wall is banked with earth or not and upon whether the charges are concentrated or elongated, with or without tamping, placed in holes or not and finally upon the depth of the holes containing the charges.

In general, in order to economize explosives, elongated charges should be placed in holes prepared for them when the wall is more than .6 meters [24 inches] thick. Emplacements for concentrated charges may be made by one or more small charges that loosen the masonry, the operation being repeated until the desired depth is obtained.

With walls nearly .8 meters [31.5 inches] thick it is preferable to use only elongated charges and when the wall is thicker than .8 meters it is better to use only gunpowder.

The character of the charges and the methods to be employed will also depend upon the amount of melinite and of time available, the size of the walls, the length of breach desired, etc.

ISOLATED WALLS.

The walls under consideration are the walls of inclosures and houses, bridge piers, etc.

In all cases, in order to obtain a breach to the full height of an ordinary wall, it is necessary for the length of the breach, and consequently the length of the charge, to be at least equal to one and a half times the height of the wall.

Elongated charges are used for inclosure walls from .3 to .6 meters [12 to 24 inches] thick and the weight of melinite per linear meter is calculated by one of the three following formulas, in which C is the weight in kilograms [pounds] and e is the thickness of the in meters [feet]:—

(1.) When the charge is merely placed at the foot of the wall:—$C=10e^2$ [$C=2e^2$].

(2.) When the charge is placed in holes in the wall:—$C=5e^2$ [$C=1e^2$].

(3.) When the charge is placed in holes in the wall and tamped.— $C = 3e^2$ [$c = .6e^2$].

That is, for a wall .5 meters [1.64 feet] thick, a charge of 2.5 kilograms (18 petards) [5.5 lbs.] in the first case, of 1.25 kilograms (9 petards) [2.75 lbs.] in the second case, and of .75 kilograms (6 petards) [1.65 lbs.] in the third case, per linear meter of the breach to be made.*

With walls of the above mentioned thickness (.5 to .6 meters) [20 to 24 inches] in actual practice a trench is dug at the foot of the wall and in it are placed three rows of petards or about 20 petards (2.7 kilograms) per linear meter [5.5 lbs. per yard] of breach. This charge is lashed to a rod of wood or to a cord whose length is equal to the breach to be made. The petards are covered with a tamping of earth from the trench. This charge is amply sufficient in all cases.

It is also possible, especially when pressed for time, to dispense with the placing of the charge in holes when demolishing walls without exceeding 4 kilograms [8.8 lbs.] per linear meter.

The charge should always be placed in holes when the wall is from .6 to .8 meters [24 to 31.5 meters] thick and when this thickness exceeds .8 meters, the charge should be placed in holes and tamped in order to avoid the use of excessive charges. The preparation of the hole for the charge may be shortened by starting at the foot of the wall with a row of petards placed end to end. The holes thus made are shaped out with a pick.

With walls thicker than .8 meters [31.5 inches] it is better to use concentrated charges calculated from the formula, $C = Ae^3$, in which the coefficient A is equal to 50 for charges merely placed at the foot of the wall, 11.5 for charges buried in the foundations 5 for charges buried in the wall to their own depth and 2 for charges buried in the wall to ½ the thickness of the latter and lightly tamped.†

The lengths of the breaches produced by these charges are

[* The words in brackets give a transposition of these formulas and results into feet and pounds.—Translator.]

[† When C and e are in pounds and feet the above values of A become 3.15, .72, .31, and .125, respectively.—Translator.]

respectively 2.5 e t, 2.2 e t, 2 e t and 1.80 e t, corresponding to the coefficients 50, 12, [illegible] and 1.*

The spacing of the charges should be equal to the lengths just given and such a number of charges should be used as will make the length of the breach at least one-and-a-half times the height of the wall. As in the case of elongated charges, it is absolutely necessary to bury the charge when the wall is 3 meters [11.8 inches] or thicker. The different charges are connected together with the detonating fuse and one of them, near the center of the desired breach, is primed.

This method of demolishing walls thicker than 3 meters [11.8 inches] requires large quantities of melinite and should be reserved for use only in cases where rapidity of action is required as, for instance, under fire of the enemy.†

In all other cases it is better to use gunpowder. The powder should be placed at the foot of the wall in charges of 15 kilograms [33 lbs.] spaced at intervals of 1 meter [39 in.; charges at 1 yard intervals] and tamped, as shown in Figure 19, Plate VII, by piling upon them such earth, stone and other general débris as may be available.

In the demolition of isolated walls whose thickness is 2 meters [6 feet] or more good results can be obtained with gunpowder only when the arrangement permits of its being well tamped. It is much more economical to use these methods.

The engineer service alone has means of sufficient power for all such cases since walls of this thickness can be demolished only by preparing in the interior of the masonry a system of mines that are so arranged as to make their craters intersect or at least become tangent to each other. The charges for these mines should be increased $\frac{1}{5}$ on account of the unusual resisting power of the material.

The mine chambers are reached by tunnels. The arrangement shown in Fig. 20, Plate VII has a tunnel for each mine chamber and can be prepared most rapidly but, as it can not be

* [illegible] corresponding to the coefficients [illegible] when e is the thickness of the wall in feet.—Translator.]

† Thus, for a wall 3 meters [11.8 inches] thick [illegible] with a resulting breach of [illegible]. For a wall [illegible] meters [illegible] high, a breach [illegible] long will be required, or [illegible] charges containing [illegible] kilograms [illegible] of dynamite, in round numbers.

fully tamped, it requires an increased charge. With the arrangement shown in Fig. 21, Plate VII, it is usually possible to tamp fully and the normal charge will suffice. In these two cases the tunnels should have the smallest possible section and the tamping should be done with the greatest care. The preparation of the chambers may be expedited by the use of successive small charges of melinite.

With walls from *1 to 3 meters* [*3 to 10 feet*] *thick*, the mines may be placed under the foundations. To accomplish this, a pit is dug at one face of the wall (Fig. 22, Plate VII,) and a chamber made under the foundations if they are not deeper than 2 meters [6 feet], or the charge is placed in the foundations themselves.

RETAINING WALLS.

When it is desired to simply throw down a retaining wall, it is only necessary to apply concentrated charges of gunpowder or melinite at the back of the wall, either placed merely in contact with it or located in chambers within the wall. In such cases it is more economical to use gunpowder since large charges are required and the tamping can be well provided for. Plenty of time will be available when works are to be destroyed.

In other respects the arrangements would be the same for melinite as for gunpowder but the charge would be reduced one-half.

Operations of this character are carried out only for the purpose of making a breach or of dismantling a fortified place and can be executed only by the engineers. The suject will be considered only to the extent of indicating concisely the method of proceedure when gunpowder is used.

The charges are calculated by the formula $C = gh^3$, in which h represents the distance from the center of the charge to the face of the wall and g is approximately equal to 3.* The intervals between charges should not be greater than twice the thickness of the wall at the point where rupture is desired.

The charges are placed in different ways according to circumstances. Use may be made of pits or drilled holes sunk from the earth surface at the top of the wall or a pit may be made at

*If C and h are in pounds and feet, g is approximately equal to .2.—Translator.

the foot of the wall to the bottom of the foundation, under which the mine is placed (Fig. 23, Plate VII).

Mines may also be prepared in the wall itself, a short distance above its base, or with the aid of a boring or drilling machine and successive small charges of melinite, an opening may be made through the wall and a chamber prepared in rear of it by exploding small preliminary charges. When chambers are made by the use of pits or tunnels, it is desirable to locate the charge within the wall itself, wholly or in part. In all cases the mines should invariably be located at the salients of the works to be destroyed.

The opening of a breach in a revetted parapet, to prepare a passage for an assaulting column, will be only briefly mentioned. The work is very difficult and dangerous and is but little used in actual service since breaches can be readily made with artillery. It is accomplished by mining a gallery into the parapet of the work in order to extend and increase the break already made by the artillery, the mine chamber being prepared at a depth dependent upon the thickness of the scarp wall.

TREES AND PILING.

Explosives are used only on pieces of timber that are more than .3 meters [12 inches] in diameter and when there is not time to fell them with the axe or saw. When using explosive, work with the axe may be limited to the preparation of plane surfaces around the circumference of the tree to receive the petards. The tree or piece of wood is encircled by a necklace or girdle of petards (Fig. 24, Plate VII,) held in place by lashings of twine. The charge is so arranged that there will be a larger amount on the side towards which it is desired to make the tree fall.

The charge required for such work is determined, in kilograms, by multiplying by 10 the square of the diameter in meters ($C=10d^2$).* From this formula it is found that charges of 7, 9, 12, 16 and 20 petards are required to fall trees or timbers with the bark on whose diameters are .3, .35, .4, .45 and .5 meters respectively.

When time permits and the necessary tools are available, economy in the use of explosives (3 petards instead of 10 for a tree .3 meters [sic] in diameter and 5 instead of 20 for one .4

* [When C and d are in pounds and feet the formula becomes $C=2d^2$.—Translator].

meters [sic] in diameter) may be obtained by placing the charges in one or more small radial holes bored in the tree with an auger. In such cases the center of the charge should be as nearly as possible at the center of the tree. The weight of the charge C in kilograms is equal to three times the cube of the diameter in meters. The formula is [1] $C=3d^3$* (Fig. 25, Plate VII.).

When the charge is heaped in a pile on one side of the tree the formula becomes [2] $C=30d^3$;* that is to say, the quantity of melinite required is ten times that in the preceding case.

SQUARED TIMBER.

The charge of melinite required to break a square timber is obtained by multiplying the area of its cross section by the coefficient 10 for soft wood or 13 for hard wood. That is [3] $C=10ab$ or $13ab$.* If the charge is placed in auger holes in the timber the formula to be used is [1] $C=3d^3$* as in the preceding case.

WROUGHT AND CAST IRON AND STEEL.

To break pieces of wrought iron, steel or cast iron, use is made of the formula, [4] $C=3000ab^3$,† in which C is the weight of the charge in kilograms, a is the width and b the thickness in meters of the piece to broken. If the pieces are cylindrical or prismatic the formula becomes [5] $C=3000d^3$,† d being the diameter of the cylinder or of the circle circumscribed about the prism.

These formulas are applicable to all ordinary dimensions with the exception that when the width a of the piece is less than .1 meters [3.94 inches] the assumption must be made that $a=.1$ meters [3.94 inches] in the formula $C=3000ab^3$.

The charge must always be placed in close contact with the piece to be broken and should be tamped, if only lightly.

* For C in pounds and d in feet these formulas become:—
[1] $C=.2d^3$, [2] $C=2d^3$ and [3] $C=2ab$ or $2.5ab$.

† For C in pounds and a, b and d in *feet*, these formulas become [4] $C=56.5ab^3$ and [5] $C=187.5d^3$.

For C in pounds and a, b and d in *inches* they become, $C=.032ab^3$ and $C=.11d^3$.

There is evidently an error in one or the other of these formulas, probably in [4] which, for approximate correspondence with [5], should read, $C=3000(\sqrt{ab})^3=3000\overline{ab}^{\frac{3}{2}}$ with equal coefficients in the two formulas as written for English units of weight and measure.—Translator.

PALISADES AND FRAISES.

To destroy palisades constructed of posts joined together and from .1 to .2 meters [4 to 8 inches] thick, it is necessary to place at their lower ends, in close contact with them, an elongated charge of 2 kilograms [4.4 lbs.] per linear meter, [4 lbs. per linear yard] formed of two rows of petards placed end to end.

If the posts are .2 to .3 meters [8 to 12 inches] thick, the charge is increased to 2.8 kilograms [6.2 lbs.] per linear meter, [$5\frac{2}{3}$ lbs. per linear yard] and the petards are arranged in three rows.

When gunpowder is used, the weight of the charge is increased in order to lessen the amount of tamping. Bags containing 10 kilograms [22 lbs.] are placed at intervals of a meter and packed closely against the posts. An effort should be made to rapidly tamp the charge with a number of sand bags.

Fraises are destroyed in the same manner as palisades, the charges being placed underneath the portion that is to be demolished.

STOCKADES.

Stockades of round timbers require charges of 30 kilograms [66 lbs.] of gunpowder per linear meter, with a light tamping. Six kilograms [13.2 lbs.] of melinite, arranged as an elongated charge, will produce the same result without tamping.

In short, the methods are the same as for palisades but double charges are required.

IRON GRATINGS OR FENCES.

To make a breach it is generally sufficient to place against the grating or fence an elongated charge of melinite of 2 to 3 kilograms [4.4 to 6.6 lbs.] per linear meter.

GATES OR BARRIERS.

Two petards [.6 lbs] applied to each of the points where the gate is attached to the masonry will usually be sufficient to break it down. In the case of a locked gate, one or two petards [.3 to

.6 lbs.] should be detonated against the lock. In the absence of high explosives, a charge of 15 kilograms [33 lbs.] of gunpowder should be placed against the lock.

Two petards [.6 lbs.] applied to each of the hinges of a wooden gate closing a carriage way will break down the gate. If it is merely locked the method to be followed is the same as for the locked gate above.

If the gate is barricaded, a charge of two petards [6 lb.] should be applied to each of the hinges and to the lock. The simultaneous explosion of these charges will overthrow the gate.

An elongated charge composed of two rows of petards, may also be placed across the gate in order to avoid the difficult task of producing too large a number of simultaneous explosions. If the gate of a carriage-way is very substantial it may be necessary to place at the bottom of it a sack containing 20 petards, 2.7 kilograms [6 lbs.].

When melinite is not available, a sack containing 15 or 20 kilograms [33 to 44 lbs] of gunpowder may be suspended against the center of the barrier at the level of the locking system.

ABATIS.

To break up an abatis, a charge of 25 kilograms [55 lbs.] of gunpowder is placed under the trunk of one of the trees without tamping. The same result may be obtained with a melinite charge of from 4 to 6 kilograms [9 to 13 lbs.]. It is better, however, to employ a charge of 12 kilograms [26 lbs.] of gunpowder and 2 kilograms [4.5 lbs.] of melinite. Breaches of from 3 to 4 meters [10 to 13 feet] may be produced in this way.

The charges are concentrated and attached to the end of poles, along which are wound Bickford safety fuzes whose lengths depend upon the distance of withdrawal. However, the placing of charges under the tree trunks is usually found to be too difficult and resort must be had to primed and lighted charges thrown into the abatis.

WIRE ENTANGLEMENTS.

The destruction of wire entanglements with explosives is not advisable. The stakes can be broken only by attaching a petard

of melinite [.3 lbs.] to each one. The number of petards must be increased if they are only placed near the stake.

TELEGRAPH LINES.

A girdle of petards arranged end to end is placed around the pole and one petard is detonated. After the pole has fallen the wires are cut and the insulators broken. A side charge of 200 grams [½ lb.] is usually sufficient for an ordinary pole. Four petards [1.2 lbs.] are required for an iron pole.

When the line is underground the cable should be uncovered and a charge of five petards [1.5 lbs.] detonated against it.

ARTILLERY.

A charge of four or five petards [1.2 to 1.5 lbs.] detonated in the bore and near the muzzle of a field piece will completely disable it. The effect is increased by plugging the muzzle with earth or clay or a few sods, through which the slow fuze of the detonator is passed.

After lighting the fuze the party should withdraw to a distance of 400 or 500 meters, in the direction of the muzzle, unless means are available for covering the piece with a layer of fascines so as to avoid the possibility of flying fragments.

Seven or eight petards [2.1 to 2.4 lbs.] detonated in the bore, will completely disable any piece.

To temporarily disable a piece of artillery, the breach is opened, a petard inserted vertically in such a way as to lean against the hinge and the breach is partially closed so as to support the petard which is then detonated.

IMPROVISED OBSTACLES.

It is difficult to state the size of the charges of gunpowder or melinite that would be required to destroy improvised obstacles such as harrows, ploughs, spiked planks, wagons, rails, etc., heaped together to form a barricade. The method to be followed should be that indicated for conditions that most nearly approximate the case in hand.

VEHICLES.

A vehicle of any kind may be disabled by detonating a con-

centrated charge of four petards [1.2 lbs.] applied to one of the axles.

ICE.

Either of the two following methods may be used to break up ice:—

1. When ice is from .1 to .3 meters [4 to 12 inches] thick, place upon the surface a charge of one, two or three petards, [.3 to .9 lb.] depending upon the thickness, prime one of them and fire the charge.

2. Make a small hole in the ice and introduce a petard [.3 lb.] which should be inserted as far as the ice is solid and should be completely submerged in the water, taking care, however, to keep above the water the joint between the detonator and the fuze.

In such work it is useless to fire several charges at the same time. It is better to use petards one at a time and the best results are obtained by gradually extending operations, each explosion producing results in the immediate vicinity of the parts previously attacked and following the line of rupture determined upon.

An elongated charge of melinite petards placed end to end on the ice and tamped with sand or blocks of ice will break up a layer of ice as thick as .5 meters [20 inches].

HIGHWAYS.

Travel over a highway may be interrupted for an appreciable time only by the destruction of bridges, whose demolition will be referred to hereafter. Indeed the damage done by blowing up the roadway with mines can generally be readily repaired and travel resumed by a few hours' work of a temporary character. The interruption may, however, be serious if the road is destroyed on the side of a hill, in a deep cut, over marshy ground and, especially, at the crossings of water courses.

When the road is on a side hill, mines should be placed towards the down-hill side. The charges for these mines is found from the formula, $C=gh^2$ (Fig. 26, Plate VIII) in which C is the weight of the charge of gunpowder in kilograms, h is the line of least resistance and g is a coefficient that depends upon the character of the soil and varies from 1.2 to 3.5. [For C in pounds and h in feet, g varies from .25 to .72].

The mines should be spaced at intervals equal to twice the line of least resistance and it is evident that the deeper are the the mines, the more complete will be the destruction.

If the road is supported by a retaining wall the mines should be placed at a distance from it equal to $\frac{7}{8}$ of the line of least resistance (Fig. 27, Plate VIII).

If no portions of the road are on side hills, the parts in cuts or on embankments should be destroyed. More delay is usually produced by filling up a cut than by damage to an embankment.

For destroying embankments, mines are used similar to those mentioned for side-hills, taking care to place the mines so that the line of least resistance (l) is towards the side slope that is to be destroyed.

Parts of a road in cuts are rendered impassable by placing in both side-slopes mines that are spaced in the same way as described above and are located sufficiently deep to throw a considerable quantity of earth into the cut. The mines should preferably be placed in the revetted parts of cuts.

To destroy a part of a road that is level with the ground, a series of mines is arranged in quincunx order at 6 meters intervals and at a depth of 3 meters They are placed in one or two rows, depending upon the width of the roadway. Damage of this character is efficacious only when extended over a considerable length of the road and for such work there should be selected a section that has impassable ground on each side (marshes, for instance).

It is advantageous to fire all the mines simultaneously in order that the resulting destruction may be more complete.

For rapid work these mines should be made with boring or drilling machines when possible, particularly as tamping may then be dispensed with. When pits or galleries are used, resort must be had to tamping that should be as complete as possible in the case of galleries.

MINOR BRIDGES.

In general it is undesirable to destroy minor bridges of spans less than 6 meters since it often takes less time to repair than to destroy them.

A *timber trestle* may be destroyed by demolishing its supports with charges that are calculated by one of the three formulas that have been given for felling trees. In order to make repairs more difficult, the supports should always be broken off below the surface of the water, the fuze of the petard being invariably placed above water.

Masonry culverts are destroyed by placing on the crown of the arch a concentrated charge of 1, 6 or 15 kilograms [2.2, 13.2 or 33 lbs.] of melinite according as the thickness of the arch is .3, .6 or .9 meters [12, 24 or 36 inches]. These charges should be covered or tamped with sand or earth and may be reduced one-half if placed in holes in the masonry.

To destroy a *metal bridge* of small span and in which the T-irons do not exceed .3 meters [12 inches] in height, there should be placed on the outside of each beam and near the points of support a charge of five petards, arranged obliquely and extending the full height of the beam. The charge should be firmly secured with wire, battens and wedges.

Suspension bridges may be destroyed by cutting the metal suspension cables at one end with petards.

BRIDGES AND VIADUCTS.

The destruction of bridges and viaducts produces a serious interruption of lines of communication and is consequently the most efficacious means of impeding the enemy's movements.

The roadway or the arches of a bridge are destroyed only when pressed for time since such parts are easiest to repair. The piers or supports should preferably be selected, with greater resulting injury. The piers are less difficult to demolish than the abutments, the supports of the bridge upon the two banks.

TIMBER BRIDGES.

When the bridges are very light, and have the roadway only 1 or 2 meters above the water, as is generally the case with bridges built during campaigns, a charge of from 10 to 20 kilograms [22 to 44 lbs.] of melinite or of 50 kilograms [110 lbs.] of gunpowder submerged to a depth of 2 meters and placed against one of the trestles will generally be sufficient to throw down several bays.

The supports may be broken either above the water with melinite or below the surface by submerged charges of melinite or gunpowder. It is better to place the charges below the surface of the water (at least .5 meters) in order to avoid the necessity of tamping and to make repairs more difficult.

If the bridges are built upon piling, the powder charges should be placed between the piles at a depth of 2 to 3 meters. When so placed a charge of 50 kilograms [110 lbs.] of gunpowder will destroy a bent composed of three piles .24 meters [9.5 inches] in diameter and spaced 1.4 meters [4.6 feet] apart.

When melinite is used the charge for each pile or support is determined separately, as in the case of trees and sticks of timber, from the formula $C=10ab$ in which C is the charge in kilograms and a and b are the breadth and width in centimeters.*

To obtain simultaneous explosions electric fuzes and exploders should be used or the various charges should be connected together by the detonating fuze.

The roadway may also be destroyed by placing 100 kilograms [220 lbs.] of gunpowder over the center of each of the beams that supports it, tamping the charge with earth or ballast. Such a charge will break down a bridge of any span.

The floor-beams may also be broken with melinite, using the formula, $C=10ab$, given above. The charge should extend the full height of the beam and must all be detonated simultaneously.

If the bridge is built on rafts a charge of 25 or 30 kilograms [55 to 65 lbs.] of gunpowder, or half that amount of melinite, placed on the roadway over one of the rafts will be sufficient to destroy two bays.

If the supports are of masonry, but of small thickness, they may be destroyed in the manner described for the demolition of isolated walls. If the masonry is heavy resort must be had to the methods given below for masonry bridges.

MASONRY BRIDGES.

PERMANENT ARRANGEMENTS.

Preparations are usually made in advance for the demolition of masonry bridges. In such cases the mines are established in

* This is evidently an error and should read *meters* (see page 52). The corresponding formula, for C in *pounds* and a and b in *feet* is $C=2ab$ or $C=.014ab$, when a and b are expressed in *inches*.—Translator.

the piers for the reason that the destruction thereby obtained is much more complete. At the same time they should be placed as low as possible in order to increase the difficulty of making repairs.

The permanent systems include powder chambers and shafts or galleries giving access to them (Fig. 28, Plate IX.). Each chamber has its corresponding shaft or gallery but sometimes two chambers are reached by the same shaft. In the latter case the chambers are placed at the two extremities of a gallery that extends horizontally from the bottom of the shaft. The walls of the shafts and galleries are provided with grooves or recesses to receive transverse pieces of timber that are intended to increase the resistance of the tamping. The latter can not be made too solid.

Access is had to these systems through a shaft with an entrance on one side of the roadway. In foreign countries powder chambers are sometimes found that communicate with the exterior only through a straight passage that does not permit of tamping.

The size of charges is not considered here since it is posted near each mine chamber.

IMPROVISED ARRANGEMENTS.

General Remarks.—If no preliminary arrangements have been made the demolition of a bridge will require a great deal of time unless access can be had to open spaces that have evidently been left in the spandrels. It will otherwise be necessary to attack either the piers, abutment or arches. Their destruction may be accomplished by the use of gunpowder or high explosives but preferably by the latter.

DESTRUCTION OF PIERS.

Piers may be destroyed with gunpowder by using ordinary mines placed on the center line of the pier and as far as possible below the springing line of the arch. The number of mine chambers is determined by fixing upon a common radius of rupture for all of them and by placing their centers at such intervals that the circles of rupture described about these points

will intersect outside of the pier, or will intersect at least in the faces of the longest sides. The corners of the pier should fall within the interior of the circles of rupture of the outside mines. A simpler method may be used and the pier may be divided into lengths of at least 3 meters [10 feet] and not more than 6 meters [20 feet] At the center of each section should be placed a mine whose charge is calculated in the same way as for an isolated wall. The amount of gunpowder necessary may be estimated at about 25 kilograms per linear meter [17 lbs. per linear foot] of pier. The mine chambers are excavated by the use of galleries which are located and excavated in the same manner as has been described above for isolated walls.

Less time will generally be required if piers are destroyed by melinite petards. In such cases a platform is suspended from the pier or built upon boats. The use of melinite dispenses with the necessity of placing the charges at the center of the pier and permits of good results with very light tamping.

When the pier has a thickness less than 1.5 meters [5 feet], it is better to place an elongated charge horizontally along one face and as low down as possible. The formula used in this case and when the charge is merely placed in contact with the pier is,* [1] $C=10E^2$, in which C is the charge in kilograms of melinite per linear meter and E is the thickness over all of the pier. If the charge is placed in a groove having a depth of .15 meters [6 inches], the proper formula is,* [2] $C=5E^2$.

For piers having a thickness greater than 1.5 meters [5 feet] it is necessary to employ concentrated charges located entirely within the masonry and tamped. The charges for such mines are calculated from the formula,* [3] $C=5h^3$, in which h is the dis ance of the charge from the most distant face of the pier, the distance between any two mines being $2h$. Simultaneous explosions are obtained by using the detonating fuze.

DESTRUCTION OF ABUTMENTS.

The most expeditious method of destroying bridge abutments is to establish mine chambers by using a miner's drill, the chambers being located about .4 meters [16 inches] from the interior face

* For C in pounds and E in feet these formulas become [1] C=.6E, [2] C=.3E, [3] $C=.3h^3$, [4] $C=1.2E^3$ and [5] $C=.022E^3$.—Translator.

of the abutment, for the reason that the formation of these chambers is somewhat difficult in direct contact with the masonry (Fig. 29, Plate VIII).

The powder charge is calculated from the formula,* [4] $C=20E^3$, in which E is the thickness of the masonry. Ordinarily two mines are employed, one being placed in each of the angles formed by the face and the two wings of the abutment (Fig. 30, Plate VIII).

When sufficient time is available the mine chambers are placed against the interior face of the abutment as low down as possible and tamped with earth or, if possible, buried in the masonry itself. In such cases the rules laid down above for retaining walls should be followed.

When gunpowder is not available elongated charges of melinite should be placed at the bottom of a trench, excavated behind the abutment wall and carried along its entire length. The earth excavated from the trench will serve for tamping (Fig. 31, Plate VIII). In such cases the charge per linear meter is calculated from the formula,* [5] $C=1.25E^3$. The method and the formula given above for piers less than 1.5 meters thick may also be employed.

DESTRUCTION OF ARCHES.

To destroy the arches of a bridge a trench at least .5 meters deep should be excavated above the center of the arch and charged with 150 to 200 kilograms [330 to 440 pounds] of gunpowder, that should be tamped with earth, stone, ballast, rails, etc. The charge should be increased near the parapets, where the resistance of the masonry is the greatest.

The charge of gunpowder may be replaced by an elongated charge of 7 kilograms of melinite per linear meter [4.5 pounds per linear foot]. It is advisable to make at intervals of 2 meters small trenches, perpendicular to the main trench and about 1.5 meters long, charging these transverse trenches also with melinite. The formula,* [3] $C=5h^3$, may also be used.

When time is pressing, an arch of a bridge may be destroyed by placing under the intrados a charge of 300 or 400 kilograms

* See foot-note on page 61.

[660 to 880 pounds] of gunpowder, supported in any practical manner in contact with the arch. A charge of 50 kilograms [110 pounds] of melinite will produce an equal result.

An arch may be broken down at the haunches or at the center by high explosives without tamping. In such cases the formula, *[6] $C=50h^3$, is applicable to concentrated charges and the formula,* [7] $C=10h^3$, gives the amount per linear meter for elongated charges.

The powder may also be simply placed in a pile upon the pavement of the bridge above the center of the arch. Three piles of 100 kilograms [220 pounds] each will destroy an arch having a thickness of 2 meters at the center. The charges should be covered with balks, planks, sandbags, etc., so as to form a light tamping. The three separate piles must be exploded simultaneously.

When but a small amount of gunpowder is available, two trenches should be excavated at the haunches of the arch and carried down to the extrados. At the bottom of one of these trenches two or three mines, each containing 12 to 15 kilograms [25 to 33 pounds] of powder, should be placed and tamped with any available material.

IRON AND STEEL BRIDGES.

TRUSS BRIDGES.

The use of gunpowder requires very large charges and a heavy tamping that is difficult to realize in campaign. For these reasons high explosives are exclusively used for the demolition of iron and steel bridges. In destroying such bridges the trusses are generally selected as the point of attack. It is necessary to break all of the longitudinal pieces in one cross-section of the truss but the web members may be neglected. In practice it is customary to make the break obliquely, in the form of a scarf, in order to facilitate the fall of the girders after the explosion. Points should be selected where the metal is thinnest and where the ends of the fallen truss will not be serviceable as supports for subsequent repairs. The selection of the cross-section is based upon these principles.

* For C in pounds and E in feet these formulas become [6] $C=3h^3$ and [7] $C=.18h^3$.—Translator.

The cross-section of rupture should be located 1 or 2 meters from the points of support (abutments or piers), for the reason that at the ends of the bridge the metal is generally thinner and the charges can be more readily placed.

In any cross-section of rupture the charge should be varied from point to point according to the character of the metal, its thickness and as to whether the plates have a full section or are riveted. As a general rule, the number of petards in each element of a charge designed to break a plate of steel or iron will be equal to the thickness of the plate in centimeters. The following table gives a general idea of the number of petards required:—

Thickness over rivets,		1 c.m.	2 c.m.	3 c.m.	4 c.m.	5 c.m.
No. of rows of petards,	iron,	1	3	5	8	14
	steel,	1	4	6	10	16

Charges should be placed as closely as possible in contact with the metal. The heads of rivets should be blown off, since it will otherwise be necessary to add the thickness of these rivet heads to that of the metal. Moreover, all charges should be as well covered as possible with planks to form a tamping.

The general formula for breaking pieces of metal is, $C = .0003ab^2$, in which a is the smaller dimension, in meters, of a rectangular cross-section of the piece, and b is the larger. The length of the charge should be equal to b^2 (sic).

To obtain the complete rupture of a beam all the elements of the charge should be detonated simultaneously and should therefore be connected by rows of petards or by a detonating fuze. If explosives are not available the piers or abutments may be destroyed, but in such cases the trusses remain intact and repairs may be easily made.

SUSPENSION BRIDGES.

The towers supporting the cables of a suspension bridge may be blown down with petards, following the methods described above for the destruction of masonry bridges. The cables or chains may be also cut with melinite, and the size of the charge may be determined from the formula, $C = 3d^3$, in which C is the charge in grams and d is the diameter of the cable in centimeters.

RAILROADS.

Since railroads are employed almost exclusively for strategic communications alone there is little gained in field operations by causing interruptions of traffic of only short duration. Nevertheless, the destruction of the roadbed proper by explosives may prove to be of great service in many cases. These damages may include the blowing up of a bridge, the destruction of considerable length of the roadbed or of special points, such as junctions and crossings.

RAILS.

Two petards will be sufficient to break a rail of either iron or steel and of any shape.

These breaks may be made either single or double, depending upon the amount of time available and the orders received relating to the work. In making a *single break* the location of the charge should be first prepared by uncovering the rail in the space between two consecutive cross ties. Two petards should be then placed lengthwise, one upon the other, and applied closely to the web of the rail immediately above the base (Fig. 32, Plate IX). They should be firmly secured in this position by a lashing around the rail, by ballast or by any other means, particularly in the case of double-headed rails. One of the petards should be primed with a slow fuze and the tamping completed by covering the charge and a part of the Bickford fuze with earth. After having ignited the fuze the party should withdraw about 100 meters up the track. The break will be about .4 or .5 meters in length.

When the rails are of the T-head pattern the rail and a cross tie can be both broken at the same time by applying to the rail, immediately above the tie, a charge of four petards formed by the superposition of two charges such as have just been described, firmly lashed together. The tie will be cut and the break in the rail will be about 1 meter long.

The damage produced by a single break is not always sufficient, however, to cause a derailment and it is better therefore to make two single breaks, that is to say, a *double break*. This is accomplished by placing on opposite sides of the same cross tie and at a distance of 1.5 meters from each other two charges of two

petards each. One of these charges is placed on the interior of the rail and the other on the exterior (Fig. 33, Plate X). The two charges should be connected by a detonating fuze and only one of them need be primed. In this manner two single breaks are produced simultaneously and about 1.8 meters of the rail will be destroyed. Two charges, placed as just described, constitute a *couple de cavalerie.*

If detonating fuze is not available the two charges should be primed with fuzes that should be of the same length and that should be lighted at the same time. It is also essential to firmly secure the charges against the rail, since a failure of the two charges to explode simultaneously might lead to the displacement of the slower charge and a material decrease in its effect upon the rail.

When a more extensive destruction is desired a *couple* of two charges, each composed of two petards, may be placed on each side of a rail joint as has just been described, and the operation may be repeated at the next joint. With T-headed rails two charges of four petards each may be used for breaking simultaneously both the rail and the tie as has been described above. The two charges should be placed upon two ties that are not adjacent to each other.

TRACK DEMOLITIONS.

A single break of a track is obtained by placing opposite each other upon both lines of rails two of the charges previously described for single breaks.

A double break is effected by two double break charges (Fig. 34, Plate X). In both cases one charge only is primed, but the two charges are connected by a detonating fuze.

FOREIGN RAILROADS.

The methods described above for producing single and double breaks of rails and tracks may be applied to foreign systems. Some foreign tracks are, however, more difficult to destroy than the French railways. It will be necessary, therefore, to sometimes substitute for charges of two petards larger groups of three, four or

five petards properly placed. It will always be necessary to determine the size of the charges required from the character and solidity of the roadbed in each particular case.

DEMOLITION OF A LENGTH OF TRACK.

The destruction of a considerable length of track may be accomplished by placing upon each line of rails at every third joint a couple of charges so arranged that each couple includes a rail joint. These joints should not be opposite each other (Fig. 35, Plate X). Ten couples arranged in this manner will damage the track over a distance equal to 15 rail lengths. All of the charges should be connected together by a detonating fuze, only one end of which need be ignited.

If a detonating fuze is not to be had, each couple should be primed with a Bickford fuze whose length should be sufficient to give the men ample time to withdraw, and should be such as to make the explosions absolutely simultaneous.

A working party of 12 men can do this work in 15 minutes.

CROSS TIES.

When a cross tie is to be broken the ballast should be removed from it at the point selected for placing the charge. The charge should consist of four petards and be placed against the rail.

To cause a double break (two cross ties) two charges, composed of four petards each, should be placed along the inside of the rail upon two ties that are not adjacent to each other (Fig. 36, Plate X). The ballast should be removed from beneath the tie directly under the charge. The explosion of these charges will destroy the two ties on which they are placed and will produce a break 2.4 meters long. If the track is laid with double headed rails the chairs will prevent the charge being placed in contact with both the rail and the ties. A charge of four petards will break the tie and the chair but will leave the rail intact.

SPECIAL POINTS.

A switch may be destroyed by placing a charge of two petards between and in contact with the moveable rail of the switch and the rail of the main line. The destruction may be made complete by breaking the switch lever with 1 petard (Fig. 37, Plate XI).

A railroad frog may be destroyed by detonating simultaneously two charges of 3 petards each, one of the charges being placed at the point of the frog and the other at the angles of the guard rails that enclose this point.

Both tracks at a junction point may be destroyed by placing three or four petards between the wing rails and the point of the frog (Fig. 38, Plate XI), at the point where the thickness of metal is double that of the rail. Two other charges of two petards each should be applied in the usual manner to the adjacent rails at the point where these two rails have the least distance between them.

A turntable may be destroyed by rotating it slightly so that its rails are not in line with those of the track and, after raising a part of the floor, detonating a charge of two petards upon the roller ring or a charge of four petards in contact with the axis of the table.

A rotating draw span may be destroyed by a charge of two petards placed upon a pinion, cog wheel, the rollers or the roller ring.

The Saxby maneuvering mechanism, the signals, etc., may be broken by a charge of one or two petards. The fixed part of the signals may be disabled by a petard placed upon the axis of rotation. The damage may, however, be limited to cutting the connecting wire or chain, by means of which the disk is operated from a distance, and by removing this mechanism.

ROLLING STOCK, ETC.

The detonation of 1 petard placed against the plates of a tank will be sufficient to cause a break at the point of contact and to make a hole having a diameter of .1 meters. The rifle bullet, model of 1886, will also penetrate such plates.

To disable entirely these tanks the valve mechanism should be destroyed. This may be ordinarily accomplished quickly by breaking the cover to the chamber in which this valve is placed under the tank. Two petards will also be sufficient, if properly placed, to break the elbow between the valve and the standpipe or the supply and discharge pipes.

The character of the work to be done in disabling a locomotive will depend upon whether the damage is to be only temporary or is to be more serious. In the first case it will only be necessary

to burst several boiler tubes by detonating in each tube one petard if the machine is cold, access being had to these tubes through the door upon the front of the locomotive.

Better results may be obtained by breaking a connecting rod with a charge of three petards, and this damage can be accomplished even when the machine is fired up. The throttle valve or the injector may also be destroyed by a charge of two petards.

In the second case each connecting rod should be broken by four petards placed upon the crank bearing. The cylinders should be destroyed by a charge of five petards placed in close contact with them at some point, and petards should be detonated upon the eccentrics of the valve gear, lubricators, springs, suspension rods, etc.

A tender may be disabled by rupturing the water tank with one or two petards placed on each side or on the stems of the feed water valves. A carriage may be disabled by detonating three petards placed between the axle box and the band that holds together the leaves of the spring. One petard will break an axle or a coupling hook.

GENERAL REMARKS UPON THE DESTRUCTION OF RAILROADS.

As has been previously stated, special or particular points should be selected for demolitions, such as:—

1. Exterior rails on curved sections, where the centrifugal force will naturally tend to produce a derailment.
2. Deep cuts, for the purpose of producing a considerable obstruction when a derailment takes place.
3. Turnouts, junctions and crossings.
4. Turntables and switches.

Without destroying important bridges or tunnels such damage may be done as will require a great deal of time for repairs, and during this time the service of the road will be suspended. Minor demolitions are always employed at the beginning of a campaign in order to hinder the concentration of troops and later on are used for the purpose of preventing quick access to a point that requires protection, a tunnel that should be preserved or a station occupied as a post. They are, therefore, a sort of accessory defense and a means of preventing surprises.

TUNNELS.

Serious interruption of railroad traffic can be accomplished only by the destruction of tunnels and important bridges, whose repair or replacement will be difficult and require much time. It is ordinarily impossible to use high explosives for the destruction of tunnels, on account of the large quantity that would be required. Should such explosives be used, however, the amount of the charge may be determined from the formula, $C=4H^3$, in which H is the distance in meters from the charge to the interior face of the tunnel. Even with gunpowder it is possible to only partially destroy tunnels with improvised works, especially when they are excavated through rock. The damage is therefore generally limited to blowing up the portals, the most accessible parts. Under stress of circumstances the work may be even restricted to the destruction of the portal furthest from the enemy, thereby requiring him to travel the entire length of the tunnel in order to clear the obstructed end.

The speediest demolition with improvised works may be obtained by placing three mines, the first of which should be charged with 1,000 kilograms and located above the arch, 20 or 25 meters from the face of the portal and 6 meters from the intrados of the tunnel. The other two, containing 600 kilograms each, should be placed behind the two side walls, 15 or 20 meters from the face of the portal, 4 meters above the rail and about 5 meters from the interior face of the walls. These are known as mines for partial demolitions (Fig. 39, Plate XI).

Mines for total demolitions are located well within the tunnel and include five charges, of which four contain 600 kilograms each and are placed behind the side walls, while the fifth contains 1,000 kilograms and is placed above the arch (Fig. 40, Plate XI).

A charge of 10,000 kilograms of gunpowder may also be placed underneath the tunnel near its central point and close to the lining. Such a charge may be replaced by 2,000 kilograms of melinite.

A temporary obstruction may be produced by dropping into the air shafts any material that may be readily accessible.

HOUSES.

A house of ordinary size may be demolished by placing on

the ground floor a charge of melinite amounting to 500 grams per cubic meter of interior contents, all of the openings having been closed. This charge may be placed in one or more heaps, depending upon the arrangement of the house. When several charges are used they should be exploded simultaneously.

Elongated charges of 1,500 kilograms per linear meter may also be used at the foot of the partition walls or the panels between openings. All openings should also be closed in this case.

The walls may also be breached from the outside by an elongated charge of 4 kilograms of melinite per linear meter. When gunpowder is used, with a limited supply of powder and plenty of time, the charges should be placed in the panels between openings and their size determined by the formulas previously given for isolated walls. If, on the contrary, there is plenty of powder available and very little time, the charge necessary for a total demolition is determined and mine chambers are dispensed with. After determining the charge in this manner, it is increased by one-half and placed in a cellar or on the ground floor in several heaps connected by trains of powder. All the openings should be closed. The amount of the charge can also be calculated in this case by dividing the length of the front and side walls by 6 or 8 times the thickness, e, of the thickest of these walls and multiplying the quotient by a weight equal to $22e^3$. When the walls are thick or the buildings arched the mines should be placed, as previously described for isolated walls, in the foundations under the corners and the panels between openings. Shafts may also be excavated to a point below the foundations.

The walls may be also breached from the exterior by placing along the foot of them sacks of powder forming a charge of 15 to 20 kilograms per linear meter. The destruction of a group of houses may be effected by using fire in connectien with large amounts of gunpowder.

FIELD WORKS.

To destroy rapidly a field work of which we have control it is necessary only to prepare in the parapet a mine with a chamber large enough to contain 150 kilograms of gunpowder.

INFERNAL MACHINES.

The destruction of the enemy's bridges when it is not possible to get near to them may be attempted by setting adrift in the current of the stream either infernal machines or buoyant mines containing explosive charges and so designed as to explode the instant they reach the bridge. Different methods are employed to fire the charge. One of the simplest methods is to use a form of alarm clock so arranged as to release at the proper moment a spring placed above a percussion cap. Use may be also made of a rod attached to the machine in such a way that it will oscillate upon striking the flooring of the bridge, the oscillation being transmitted is such a way as to fire the charge.

In another method two casks are placed one within the other with an interval between them that is filled with potters' clay or some other impermeable material. The gunpowder or other explosive for the destruction of the bridge is placed within the inner cask. The charge is provided either with a detonator primed with a Bickford fuze or with a slow fuze.

All of these machines have the disadvantage of being easily avoided by means of booms or pile barricades that deflect them from the bridge, or by guard boats that perform the same duty.

Works of this character can, moreover, be prepared at leisure, and there is no necessity of going further into the subject at this time.

WORKS FOR THE IMPROVEMENT OF NAVIGATION.

Should it become necessary to interrupt navigation upon a stream it may be accomplished by destroying, in the method previously described, the various works used for its improvement, such as dams, weirs, dikes, locks, etc. Navigation may also be obstructed by sunken boats, booms and other obstacles of the same character. Obstructions of the latter character may be removed by means of torpedoes or submerged mines when navigation is to be resumed.

AUTOMATIC MINE.

The insurgents in Cuba employed a very simple machine for automatically exploding a mine under a moving train. The

following description of this machine, known as the Roqué torpedo, is taken from the *Memorial de Ingenioros* of February, 1898. It was successfully used on several occasions.

A ratchet wheel, R, is mounted loosely upon an axis formed by a flat headed wood screw, V, and within a wooden box with a moveable cover (Fig. 41, Plate XII). The rod, T, carries a pawl and has a motion in a groove parallel to the plane of the wheel, the spring, C, opposing the motion of the rod and pawl. The passage of the car wheels in succession over the rod, T, gives it a reciprocating rectilinear motion that is transformed into a progressive rotation of the ratchet wheel, R, by means of the pawl, D. When this wheel has advanced a certain number of teeth, the lug, E, comes in contact with the trigger, F, and depresses it, releasing the catch, G, of the firing pin, P, which is driven by a spiral spring against the primer, I. The explosion is communicated to a charge placed under the ballast.

The machine can be regulated so as to produce the explosion after the passage of n wheels. For this purpose the teeth of the ratchet wheel are numbered from a point corresponding to the lug, E. Before the explosion can be produced the wheel must be revolved so as to bring the tooth marked n opposite the end of the catch, G.

To the top of the box is secured a strap of iron that is bent up at both ends so as to enclose the base of the rail, to which it is attached by means of a wedge (Fig. 42, Plate XII).

CHAPTER VI.

CONCLUSION.

THE IMPORTANCE OF DEMOLITIONS.

As a general conclusion, it must be acknowledged that the destruction of obstacles in campaign will be of more importance than heretofore, mainly for the reason that high explosives have rendered more easy the execution of demolitions on a very large scale. It should, however, at the same time be stated that the necessary steps have not been generally taken, for making available the means necessary for executing these demolitions with modern methods.

Indeed, reference has been previously made to the fact that in the infantry and cavalry only special men in very limited numbers receive suitable instruction in this work and that the means for this instruction, explosives, are too parsimoniously issued.

Moreover, the general rules and the principles to be followed in such work are too vague and too widely scattered. Under article 108 of the regulations for troops in campaign, and under the provisional instructions of December 24, 1896, for cavalry in campaign, a detachment commander who is entrusted with the execution of a demolition divides his detachment into two parts upon arriving at the given location, but no information or general instructions are given with regard to the disposition to be made of these two parties. The most important of these two parties is entrusted with the security of the command and the other with the execution of the demolition, in which it must *act according to circumstances.*

PRACTICAL KNOWLEDGE.

It is important, therefore, that detachment commanders should be informed as to the results that may be obtained with the means at their disposal and as to the methods to be followed in executing demolitions that may be entrusted to them. It is essential that all officers should be as fully informed as possible upon the effects of explosives and of the methods of executing demolitions, but it is still more important that they should have such practical experience in this work as will create a personnel thoroughly trained in its supervision as well as in its execution. Operations of this character should be as familiar as any other drill and to the largest possible number of men. They occur almost every day during a campaign and it is necessary that they should be executed readily, *acting according to circumstances*, and with the widest possible previous study of all of such circumstances as are apt to be found in actual service.

For these reasons and for assuring the instruction of the men, Austria requires the execution annually by each company of engineers and of pioneers of a drill for the demolition of an iron bridge under campaign conditions, using simulated charges and appliances. Moreover, each instruction district is provided with wooden models of various types of iron bridges with charges and firing connections in place, but all of full size.

This system should be followed for all troops that may be required to execute demolitions in order that they may become acquainted with conditions approaching as nearly as possible to those with which they will actually have to do and at no great resulting expense. Nevertheless, actual practice is indispensable and this has been very efficiently provided for cavalry regiments which have at their disposal the necessary material for instruction in barracks and during maneuvers and are also provided with petards, detonators, etc., for executing annually the actual firing of charges.

DISTINCTIONS TO BE MADE AS TO DEMOLITIONS.

In conclusion it is essential to note the following marked differences in the different demolitions that may arise in campaign:—

1. Demolitions of slight importance and of daily occurrence, such as the cutting of a highway or railroad, the re-establishment of communications, the breaching of a line of works requiring very few men, the placing of a few charges under conditions of little difficulty and such as can be executed by troops of all arms who have been previously and suitably instructed in this special work.

2. Demolitions of important structures and which can be executed only by engineer troops or at least under the direction of engineer officers.

As a matter of fact, the first are much more common, but cases may arise in which the troops entrusted with their execution have not the necessary facilities. For instance, a cavalry scouting party may not be equipped for the execution of important demolitions in advance of the army. It would therefore become necessary to attach to them at such times detachments of engineers provided with the necessary appliances and the speediest means of transportation for reaching the desired points. There should perhaps be organized for such work either mounted detachments of engineer pioneers or at least bicycle detachments.

An endeavor has been made to group together and to properly arrange in the best possible manner everything relating to this important question of demolitions, making use of all official and other documents that have appeared upon the subject. A close study of the subject has made it apparent that while a great deal of attention has been given to the means of reaching a solution there is room perhaps for improvements in the equipment of existing organizations by the addition of many indispensable adjuncts. A pronounced advance in this direction has been made for cavalry regiments, and very benefical results would no doubt be had by extending the same facilities to the infantry.

Plate I

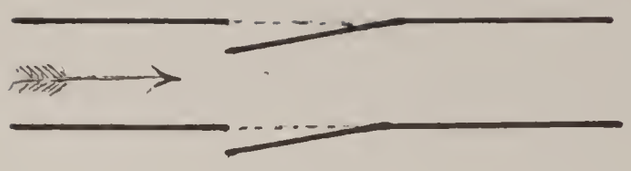


Fig. 1.



Fig 2.



Fig. 3.

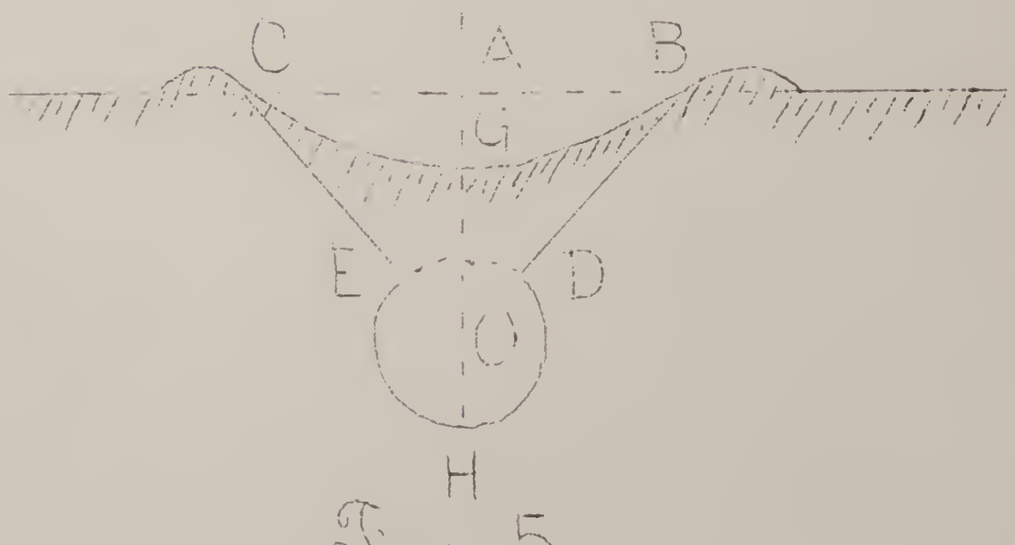
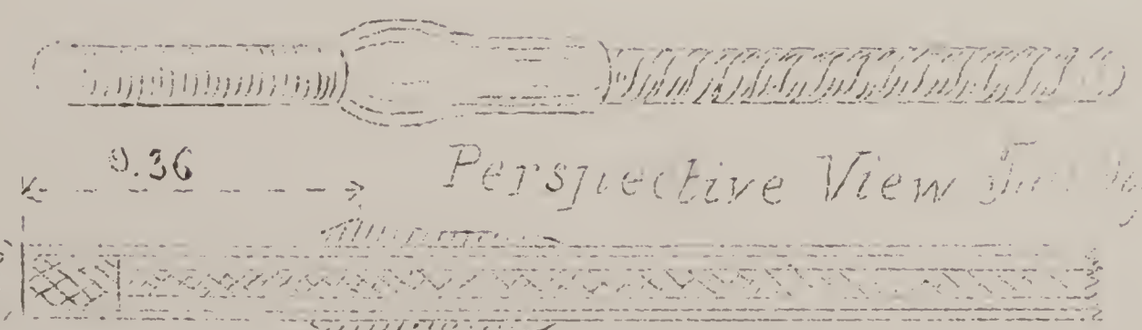


Fig. 5.

Plate II.



Fig. 5



Perspective View

Fig. 8 Longitudinal Section
Full Size

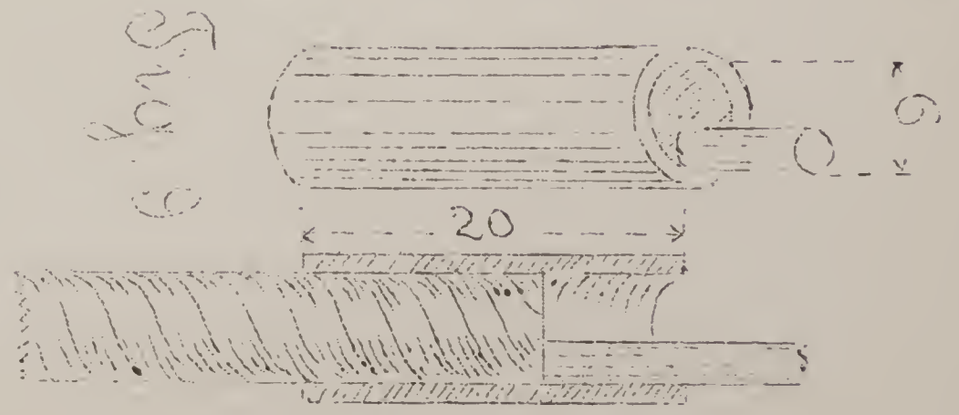


Fig. 6



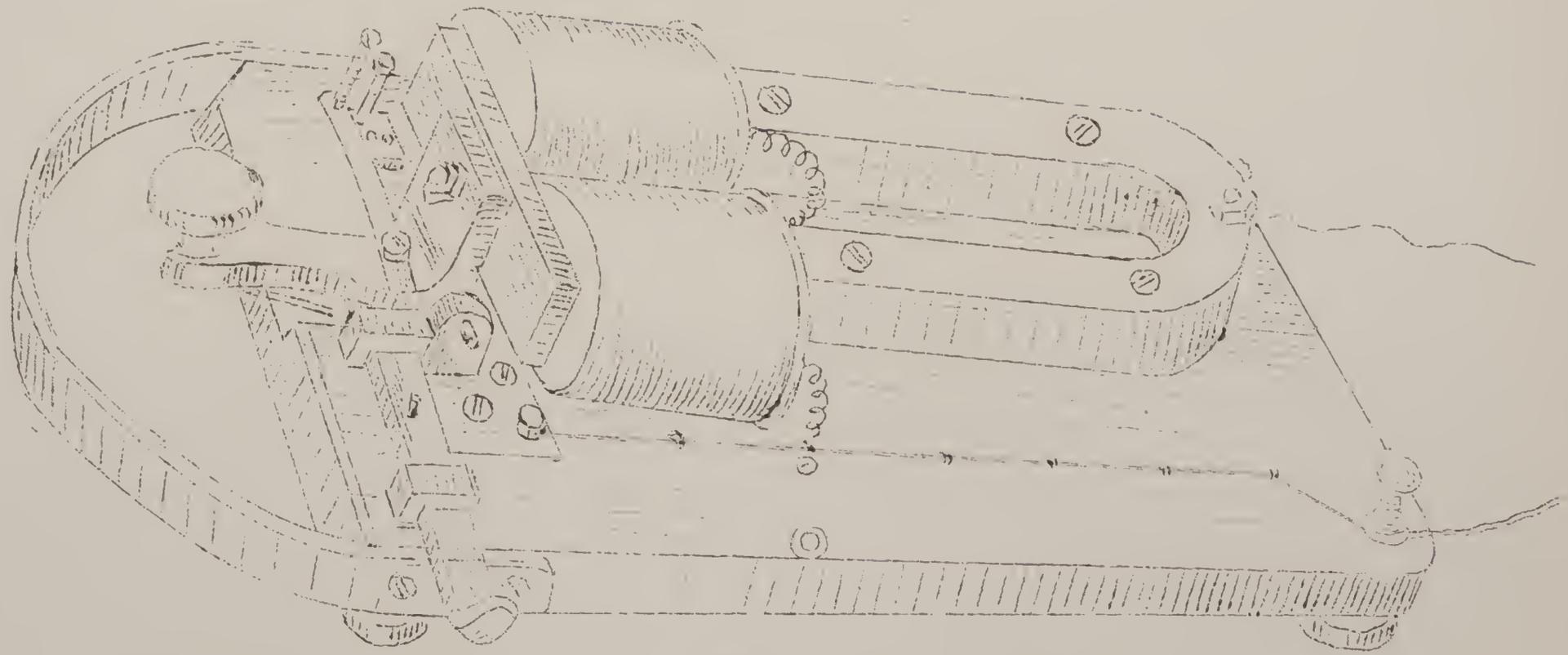


Fig. 14.

Plate V.







Tafel VII.



Fig. 19.



Fig. 22.

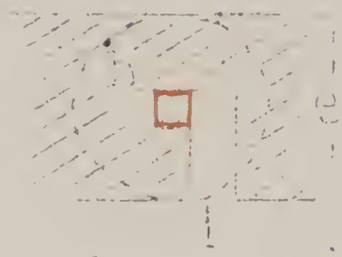


Fig. 20.

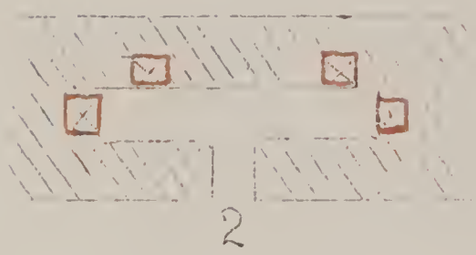


Fig. 21.



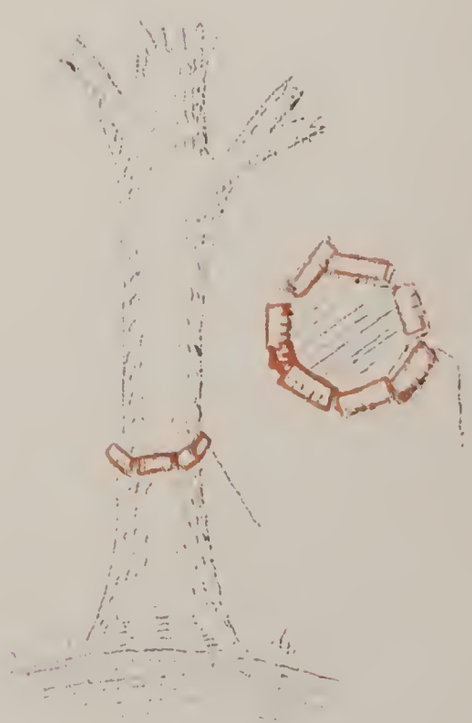




Fig. 25.

Fig. 24.

Tafel VII.



Fig. 26.



Fig. 27.

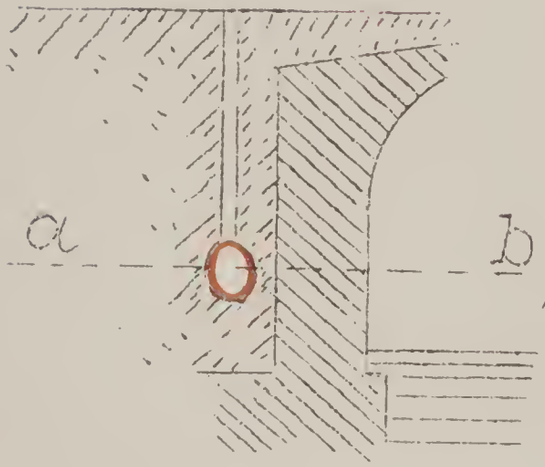


Fig. 29

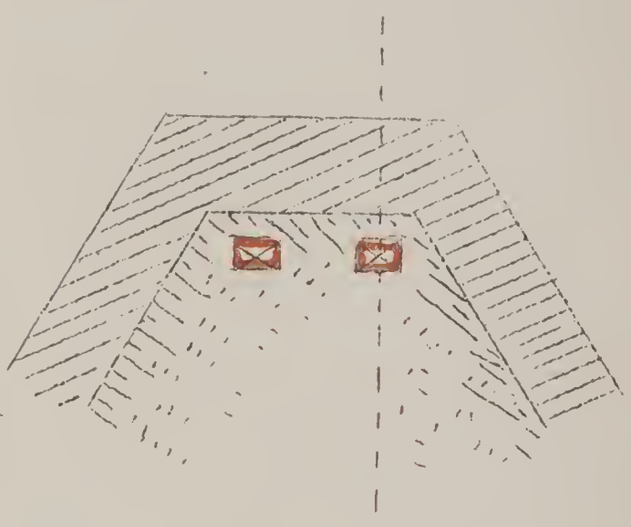


Fig. 30.

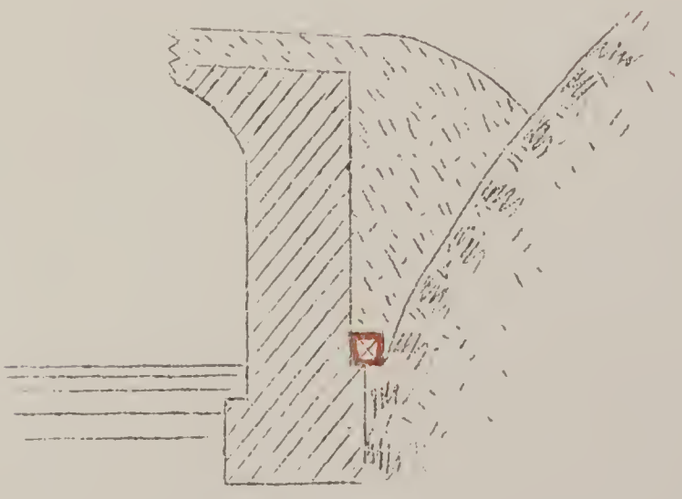


Fig. 31.

Plate IX.

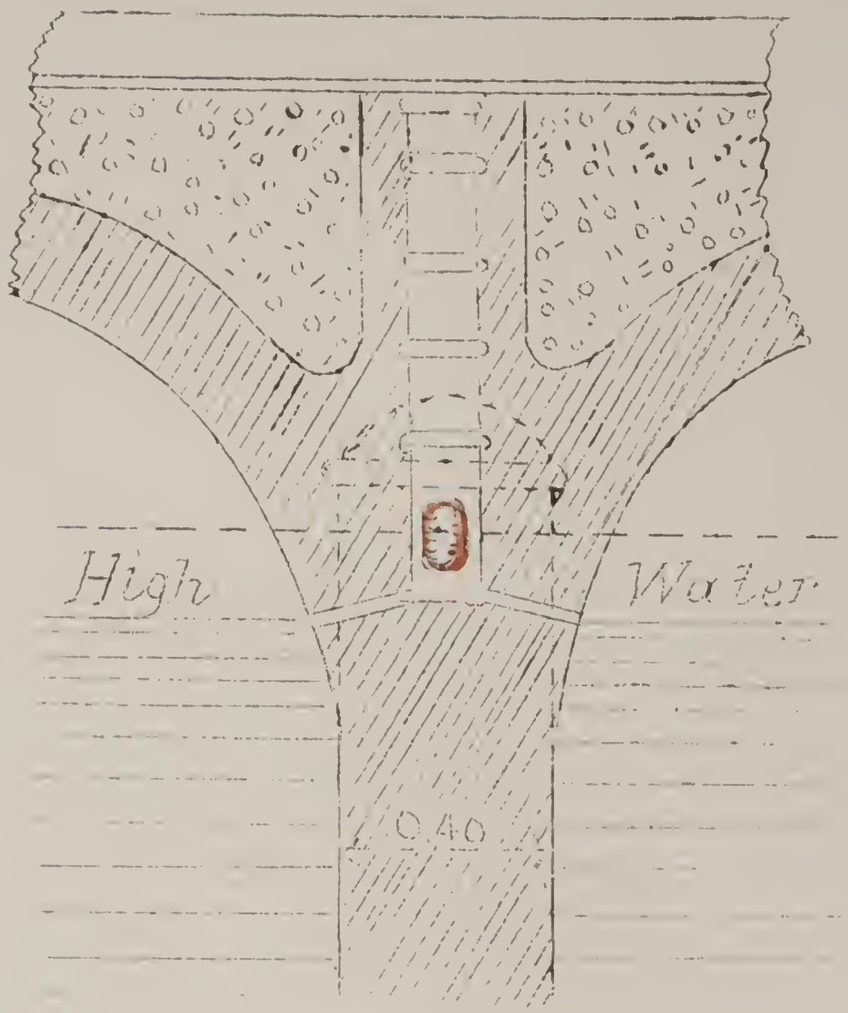


Fig. 28.

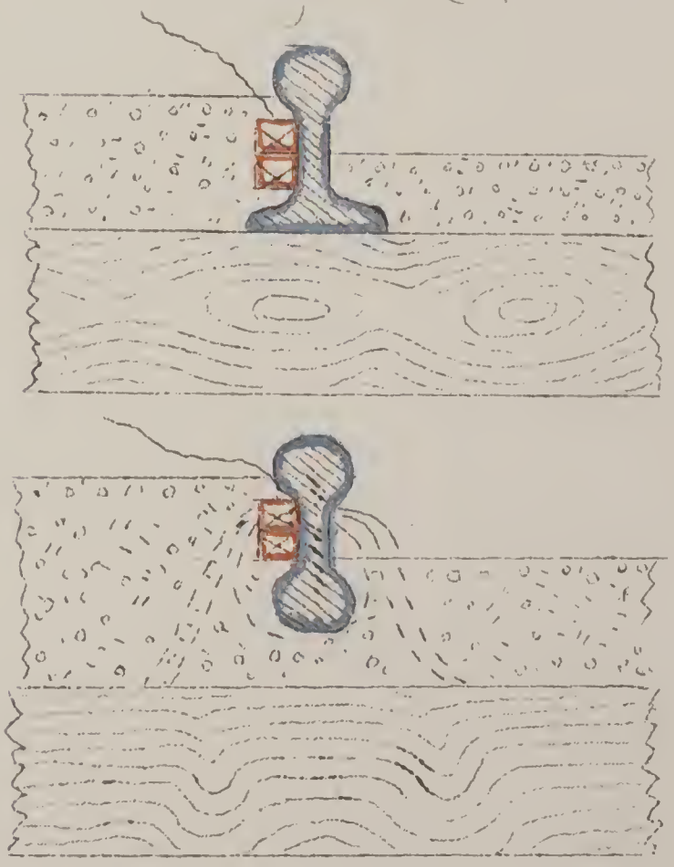


Fig. 32.





Plate X.



Fig. 33.

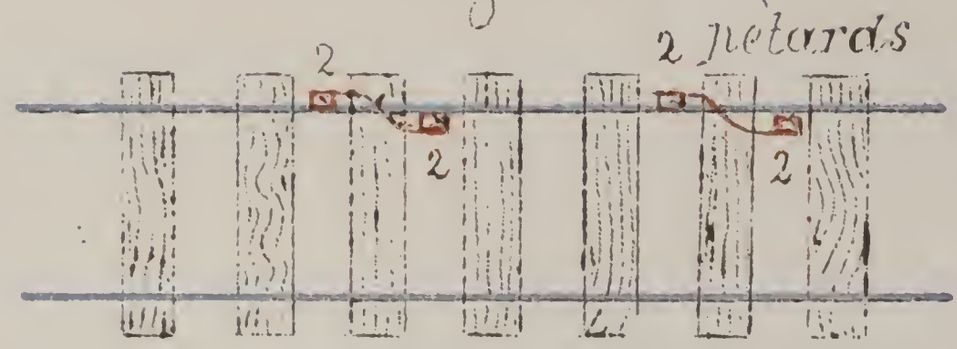


Fig. 34.



Fig. 35

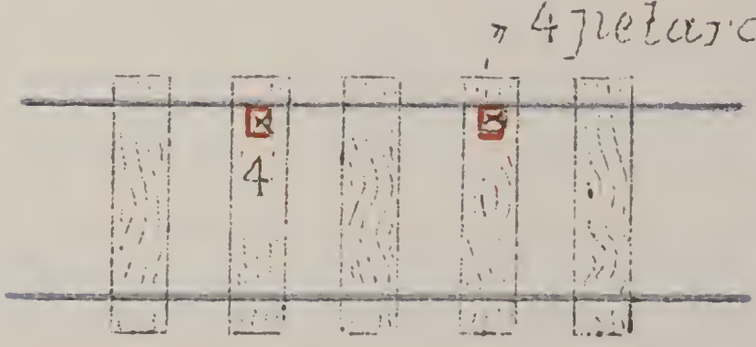


Fig. 36.

Plate XI.



Fig. 37.

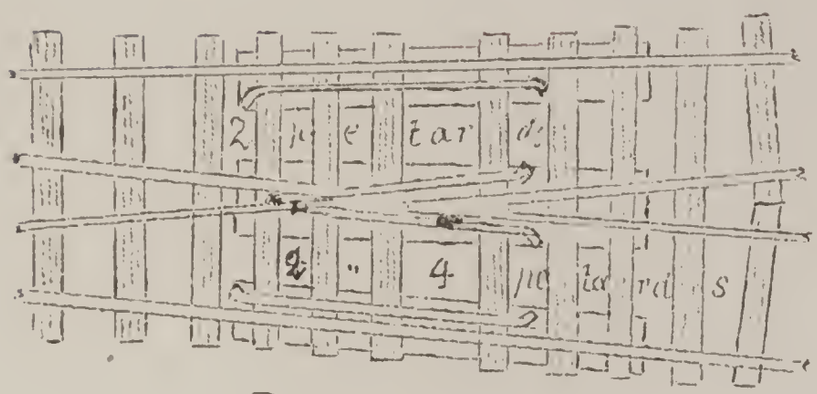


Fig. 38.

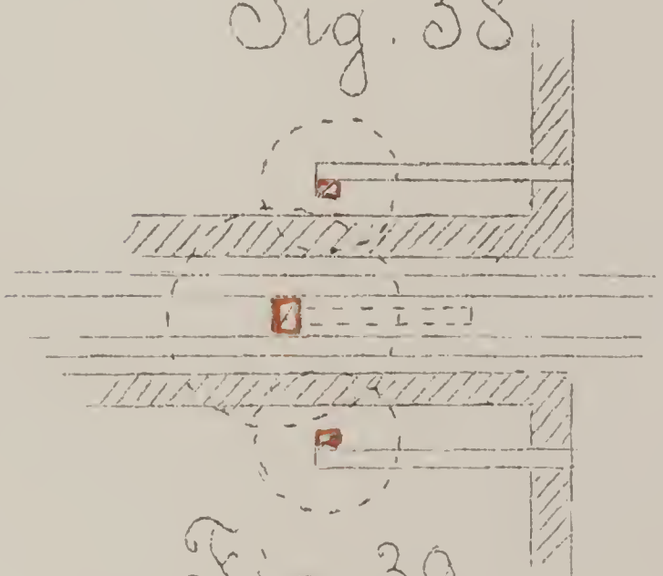


Fig. 39.

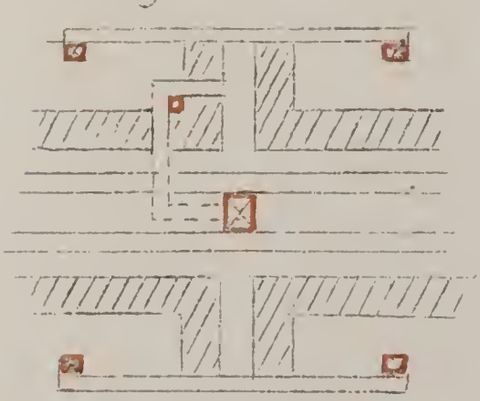


Fig. 40.

No. 5.
OCCASIONAL PAPERS,
ENGINEER SCHOOL OF APPLICATION,
UNITED STATES ARMY.

REPORT

OF

LIEUTENANT W. G. CAPLES,

CORPS OF ENGINEERS, U. S. ARMY,

UPON

THE CONSTRUCTION

OF

THE CALAMBA-BATANGAS ROAD,

LUZON, P. I.

PRESS OF THE ENGINEER SCHOOL OF APPLICATION,
WASHINGTON BARRACKS, WASHINGTON, D. C.
—1903—

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REPORT OF LIEUTENANT W. G. CAPLES, CORPS OF ENGINEERS, U. S. ARMY, UPON THE CONSTRUCTION OF THE CALAMBA-BATANGAS ROAD, LUZON, P. I.

BAY, LAGUNA PROVINCE, P. I.,
April 8, 1903.

BRIGADIER GENERAL G. L. GILLESPIE,
CHIEF OF ENGINEERS, U. S. ARMY,
Washington, D. C.

(Through Military Channels.)

GENERAL:—In accordance with the instructions of your letter of July 11, 1901, I have the honor to report the completion of the Calamba-Batangas road.

DESCRIPTION OF THE COUNTRY.

1. The country through which this passes is a high ridge between the Loboo Mountains, the Lipa Mountains, and Mount Maquiling, on one hand, and Lake Taal on the other. This ridge rises from the Laguna de Bay for a distance of 20.5 miles, where it is 1160 feet above sea level, and then falls for 19 miles to sea level at the Bay of Batangas. Its general configuration is a series of short plateaus, connected by sharp slopes and intersected by deep ravines.

2. The soil is volcanic ashes and sand to a depth of over two hundred feet. No ledges of stone exist, save in the mountains, which are inaccessible for wheeled transportation.

3. From June to December is the rainy season. The soil becomes a mass of sticky mud through which wheeled transportation can not be used. Work during these months is almost impossible. Earth work

done in this season inevitably fails. From December to June is the dry season. The almost total absence of rain during these months is scarcely less objectionable than the excess of rains in the rainy season. During the dry season the roads are full of impalpable dust. Newly graded road becomes dust and the earth will not pack. At the time work on this road opened, there was nothing in Batangas or Laguna Provinces worthy of being called a road.

PROJECT.

4. To build a road from Laguna de Bay, through the towns of Calamba, Santa Tomas, Tanauan, Lipa, San Jose, and Batangas, to the Bay of Batangas. Work was pursued under the authority of the Division Commander, with funds appropriated by the U. S. Philippine Commission. No records of this work, previous to May, 1901, are in this office. Data, previous to September 7, 1901, except for the work done on the section from Laguna de Bay to Tanauan, from May, 1901, to September 7, 1901, are only approximate. The length of the road is 39.5 miles.

HISTORY OF WORK ACCOMPLISHED.

5. Work opened about October 1, 1900, with 1st Lieutenant S. A. Cheney, Corps of Engineers, with a detachment of Company B, 1st Battalion of Engineers, at Calamba, P. I., with funds appropriated by the U. S. Philippine Commission, for the Calamba-Nasugbu road, $150,000 Mexican. Lieutenant Cheney was assisted by 1st Lieutenant W. H. Raymond, Artillery Corps, and later by 2d Lieutent W. H. Lee, Corps of Engineers, and 2d Lieutenant W. G. Caples, Corps of Engineers. On May 27, 1801, Lieutenant Cheney was ordered relieved and left in local charge, at Batangas, Lieutenant Raymond; at Lipa, Lieutenant Lee; at Calamba, Lieutenant Caples. The untimely death of Lieutenant Lee caused Mr. W. J. Kipp (late Captain, 11th Cavalry, U. S. V.), to be placed in local charge at Lipa. Captain William W. Hartz, Corps of Engineers, relieved Lieutenant Cheney in September, 1901, and directed Lieutenant Caples to take local charge of the entire road, September 7, 1901. A detachment of Companies E and H, 2d Battalion of Engineers, relieved the detachment of Company B, on September 28, 1901. First Lieutenant George B. Pillsbury, Corps of Engineers, relieved Lieutenant Caples of local charge from January 27, 1902 to January 31, 1903.

6. During the year 1900, laying out, clearing, grading and ditching a new line from the road from Calamba to Tanauan was done. During the year

1901, the road was completed from Laguna de Bay to Tanauan, and from the Bay of Batangas to Batangas. 3.5 miles of grading, ditching and tufa surfacing were put in by Lieutenant Raymond, between Batangas and San Jose. The surfacing and a good share of the ditching, between Batangas and San Jose, failed during the rainy season, requiring rebuilding the next year. 7.5 miles of ditching and grading, and 2 miles of tufa surfacing were placed by Mr. Kipp, between Lipa and San Jose. This entire section failed totally during the rainy season. Traffic, over the sections which failed, was maintained by corduroying the worst parts of the road.

7. During the year 1902, the section from Laguna de Bay to Tanauan was maintained in good order. The grading and ditching of the entire road was completed. A tufa fill, from San Jose to Lipa, was completed, in order to permit work during the rainy season. 6 miles and 595 yards of metalled road were built between Tanauan and Lipa. 5 miles miles and 1538 yards of metalled road were built between Lipa and San Jose, and the road from Batangas to San Jose, 9 miles, was completed.

8. During the year 1903, the road was completed on March 20, by building 3 miles and 1165 yards of metalled road between Tanauan and Lipa, and 1 mile and 1102 yards of metalled road between Lipa and San Jose.

BRIDGES AND CULVERTS.

9. All the principal bridges were built by the Spaniards, prior to the American occupation. A number of culverts were built at the same time. All these bridges and one culvert were repaired. One bridge of 25 feet span was placed. This bridge was built on stone abutments and a central pier. The roadway was composed of plate girders, taken from a ruined bridge, and floored with plank. Culverts were of three types: first, a box culvert with grouted floor and stone walls, topped with creosoted pine; second, a buried cement pipe, 12 inches in diameter; third, wooden box subdrains. In all, one bridge and sixty-six culverts were installed, and five bridges and one culvert were repaired.

MATERIALS USED.

10. In this section of the islands there is scarcely anything which is used for road building in the United States. Everything which gave promise of being good was tried.

11. Creosoted Oregon pine and native woods were used for flooring bridges and culverts. The side walls of culverts were built of tufa

blocks, called adobe stone. The floors of culverts were of crushed, grouted, and tamped tufa. Portland cement was used in constructing culverts and bridges.

12. For road metal, many materials were tried. The list includes tufa (or adobe stone), river pebbles, sand from the San Juan River, pit sand, and coral. The construction was varied by mixing these materials.

METHODS OF CONSTRUCTION.

13. The culverts of stone and wood, box type, were constructed by laying a floor of well tamped and grouted tufa, 6 inches thick, to prevent the undermining of the side walls. The side walls were faced with blocks of tufa set in cement. In rear of these were grouted and tamped tufa, giving the walls a total thickness of 18 inches. 4 x 6 inch beams, spaced 3 feet center to center, were let into the masonry 5 inches for roadway bearers. The one inch which these beams projected was allowed because it was not thought advisable to set them flush with the masonry, owing to the unequal settling of the latter. 3 x 12 inch planks were used for topping. A guard beam, 4 x 6 inches, was set at each end of the culvert to prevent wagons from going too close to the edge. The cement pipe culverts were made by laying the pipe in a trench and plastering the joints with mortar. As soon as the mortar set the trench was filled with earth and tamped. All mortar used was composed of cement 1 part, sand 5 parts. Wooden box culverts were built of 2 inch native timber and buried.

14. The principal grading of the road had been done by the Spanish. Incomplete work was finished so that no slope should exceed 6 per cent. The majority of the slopes are 3 per cent or less.

15. The metalling of the road was done with the best materials which could be obtained in the vicinity. The following types of metal were used: Type "A," used near Calamba: a layer of volcanic stones crushed and covered with sharp sand from the San Juan River; metal 16 feet wide by 6 inches thick. Type "B," used near Calamba: a tufa fill, 16 feet wide by 6 inches thick, covered with river pebbles 4 inches thick, covered with river sand from the San Juan River, 2 inches thick. Type "C," used near Calamba and Tenauan: river sand from the San Juan River, laid 12 to 16 feet wide and 6 to 12 inches thick. This sand is from eruptive rocks, clean, sharp, and contains a large share of gravel. It possesses the property of packing and forming a hard smooth metal, Type "D," used near Santo Tomas: a 6-inch Telford pavement of volcanic stones covered with 2 inches of finely pounded disintegrating feldspathic rock, covered with 1 inch of sand. Type "E," used near

Lipa, San Jose, and Batangas: volcanic pit sand, 14 feet wide by 4 inches thick, over a 4-inch tufa fill. Type "F," used near Tanauan, Lipa, and San Jose: volcanic pit sand 14 feet wide by 6 inches thick. Type "G," used near Batangas: crushed coral rock and river pebbles, 14 feet wide by 6 inches thick, covered with 2 inch volcanic pit sand. Type "H," used near Batangas: crushed trap rock 4 parts, and crushed coral 1 part, intimately mixed, and laid 16 feet wide by 8 inches thick. The whole covered with 2 inches of pit sand.

SECTIONS USED.

15. The section used varied with the builder. Cross section by Lieutenant Cheney: width of road bed, 16 feet; width of berms, 0 feet; width of ditches, 2 feet; depth of ditches, 1 foot; cross section by Lieutenant Raymond: roadbed on arc of an ellipse, with crown of 8 inches, and width of 24 feet; ditches, 3 feet wide by 2 feet to 9 feet deep; cross section by Lieutenant Caples, approved by Lieutenant Pillsbury: roadbed, 16 feet wide, lateral slopes of $\frac{1}{48}$, berms, 2 feet wide, with slopes of $\frac{1}{12}$; ditches, interior slope of $\frac{1}{6}$ and 8 feet wide, exterior slope of $\frac{1}{1}$ and 2 feet wide.

RESULTS OF WORK.

16. The cross section by Lieutenant Cheney gave satisfactory results, but it is open to the objection of having no berm which causes the metal to be occasionally forced into the ditch and makes the passage of wagons difficult. The cross section by Lieutenant Raymond gave only fair satisfaction, the ditches being extremely liable to fail by caving in and dangerous to traffic. The cross section used by Lieutenant Caples, approved by Lieutenant Pillsbury, gave good results but is open to the objection that wagons drive in the ditch in dry weather.

17. Road metal of the types "A," "B," "C," and "G," gave excellent results, wearing well and requiring very little repair. Type "D" required more sand but was very good in its final result. Types "E" and "F" require an annual addition of 1 inch of pit sand over their entire length. If these repairs are made, the road lasts well. If they are not made, the life of the road is only two years. Type "H" is by far the best type. It forms a surface hard enough to turn a pick, just smooth enough to prevent jolting wagons which pass over it and, at the same time, always offering secure footing to animals.

18. The buried wooden box culverts rot out in less than two years and are highly unsatisfactory. Box culverts with stone walls and timber tops are open to the objection that the best obtainable lumber will soon rot when exposed, as is necessary in this work. The cement pipe culverts

have given the best results. They are cheap, durable, and very satisfactory.

19. The general result of the work has been highly gratifying. From a military standpoint this road is of the highest importance. The road pierces the center of the provinces which were the last to remain in armed rebellion to the United States. The stations along the line of the road were heavily garrisoned and made the bases of supply for military movements. By means of this road troops could assemble so as to be in position to reach the main rebel strongholds. During the process of work a supply road was hastily built from Lipa to Rosario. Supplies were sent from Batangas, via Lipa to Rosario, for use in the final operations which resulted in the surrender of the rebel chief, Malvar. At the time work opened it was a days' march for mounted troops from Tanauan to Calamba. One year later during the rainy season, the garrison of Calamba was put into wagons and proceeded, in forty minutes, to their position 7 miles from Calamba, when it was desired to cut off the retreat of the rebel leader Gonzales. During the rainy season of 1900, the road was impassable for wheeled transportation. During the rainy season of 1901, vehicles could be taken at a trot from Laguna de Bay to Tanauan. From Tanauan to Lipa the road was, in places, impassable for horses. From Lipa to Batangas the road was passable with difficulty. During the rainy season of 1902, wagons could be taken at any gait over all completed portions of the road. With the exception of 1.5 miles between San Jose and Batangas, the incomplete portions of the road were passable with difficulty to all classes of wheeled transportation. A cut-off was built around the impassable section and wheeled transportation moved over the entire road every day. During the approaching rainy season it is believed that wheeled transportation will be able to pass over the entire road at any gait, regardless of the weather. From a civil standpoint this road is the only outlet for the commerce of a very rich and populous section of the island. Its effects on commerce were immediately felt. Upon the completion of the section from Calamba to Tanauan, the market at Calamba trebled in size and finally had to be moved to a new and more commodious situation. Rates of transportation fell to one-third or one-fourth the former rate, as soon as the various sections were completed. From a muddy trail, passable only six months of the year, the road has become a broad, open highway, passable at any season, and will remain so, as long as ordinary repairs are maintained.

COST.

20. The incomplete condition of the early records makes it impossible to say exactly what amount was expended between Calamba and Batangas

from Act 1, United States Philippine Commission. The sum is approximately $110,000 Mexican. From Act 311, United States Philippine Commission, $91,934.42 Mexican, was expended, making the total cost approximately $201,934.42 Mexican. This gives the average cost per mile at $1,966.25 United States currency. Free transportation, forage, and supplies were furnished by the Quartermaster's Department, and tools and free superintendence were furnished by the Engineer Department. The exact money value of these can not be ascertained, but, had they not been furnished, the cost of the work would have exceeded $450,000 Mexican.

METHODS OF WORK.

21. Letting of work by contract was impossible, there being no reliable contractor. Work was organized by placing at each station a small detachment of engineer soldiers under the charge of a non-commissioned officer or responsible private. At times the demand for engineer troops was so great in the islands that a sufficient number of soldiers could not be obtained. Civilian foremen were hired to make up the deficiency, but they were discharged as soon as soldiers could be obtained, because the work done by them, with one exception, was never so satisfactory as that done by engineer soldiers. In the excepted case the civilian foreman was a discharged engineer soldier. The non-commissioned officer at each station was taken over a portion of the road assigned to him and carefully instructed as to what work was to be done and how to do it. Whenever practicable, drawings and written instructions were furnished each non-commissioned officer. The privates, under direction of the non-commissioned officers, were assigned to duty with the working parties. Until the soldiers understood their duty, six visits each month were made to each station. Afterwards, visits were made as often as other work would permit. Duties were assigned to soldiers at first temporarily until it could be determined where they were the most efficient. Later they were assigned to the portion of the work for which they were best fitted. Near the close of the work, when the number of stations was reduced and two good men were available for each position, the soldiers were given a chance to learn each portion of the work. With few exceptions the men of the detachment now understand all the different phases of the work.

22. Whenever they were available, wagon trains, with a wagonmaster in charge, were attached to each station. The wagonmaster was placed under the orders of the non-commissioned officer in charge, except in matters pertaining to the health of the animals. Temporary stables were built for the animals, and in two instances where other quarters could not be obtained, temporary quarters were built for the men of the train and

detachment. Great difficulty was experienced with disease in the trains. The feeding of native grass caused surra and sporadic cases of glanders. Veterinary aid and medicines were obtained. Dr. Coleman Nockolds, Veterinarian, 1st Cavalry, took the care of the Batangas train, diagnosed the disease, and took the necessary steps for its eradication. Ninety-six animals were lost before the disease was stamped out. American forage was fed for a time until an order for its issue could no longer be obtained. From that time until the close of the work sporadic cases of surra and glanders broke out, but there were no more epidemics of these. This loss in animals resulted in a delay to the work of about six or eight months in the time of completion.

23. The manual labor was all done by natives. At first it was necessary to hire natives of the wealthier class for foremen and require them to furnish their peons for laborers. This failed, owing to the laziness, incompetence, and unreliability of the upper class of natives. The second system, consisting of employing natives of the poorer class for foremen, proved excellent. First, the native foremen said they could not get men. Each foreman was then allowed twenty men in his gang and paid 4 cents Mexican, per day for each laborer in his gang. The gangs at once filled up and remained so. Many of the soldiers learned to speak some Tagalog, which proved of great value in instructing the natives in the work. In handling the natives there is little good done by dealing with the individual laborer. When fault is found with him his foreman should be sharply reprimanded for the laborer's work. Kindness and mercy seem to be qualities which the Filipino can not understand. Force and justice he understands perfectly. This makes it necessary, in order to get good work from them, to rule them with a just but iron hand. As soon as they understand that they have to work they will do so, otherwise no work can be obtained from them. The natives were divided into gangs of twenty laborers and a foreman. From two to four gangs were assigned to each soldier, depending on the number that the soldier could watch. The gangs were required to assemble at the quarters half an hour before the time for work and receive tools. So many tools were stolen under this system that it was decided to issue tools to them for a week at a time, and if the tools were not present at the end of the week, their money value was deducted from the pay of the foreman and the laborers. Since then the loss of tools has been insignificant. Payments were tried both by the task system and by paying a fixed amount for each day. Payments for fixed tasks failed because the natives would not work under this system. Pay by the day was adopted and whenever the amount of

work done by a gang was deemed insufficient the entire gang was discharged. Discharging each pay day, the gang which had done the poorest work since the last pay day, proved very effective in obtaining work of a good quality.

SPECIAL MENTION.

24. The enlisted men have shown the devotion to duty so necessary for good engineer soldiers. In all kinds of weather and under all kinds of conditions they have attended faithfully to their duty. At times it was necessary to place them alone with large gangs of natives far from the garrisons and where other troops always went in armed parties. Their duty in itself was far from easy and they saw themselves working much harder than the other troops in the garrison with them, yet never a word of complaint was heard.

25. Lieutenant Cheney has already made special mention of those of Company B, who did the best work. I concur in Lieutenant Cheney's recommendations and have no further recommendations. From the detachments of Companies E and H, 2d Battalion of Engineers, special recommendation for intelligent and faithful service is made of the following men: Sergeant Henry F. Furman, Corporal William B. Bell, and First Class Privates Bothwell, Evans, Kolberg, Lathrop, Leist, and Miersch. Special mention is made of Sergeant William Reeker, Company H, 2nd Battalion of Engineers, for faithful and intelligent services; for ability to organize and handle work, and for unusual ability as a disciplinarian.

GENERAL REMARKS.

26. The condition of climate, the materials of construction, and kind of labor were all new. No reference could be had to the experiences of others because none existed. The work may be classed as an experimental road. A number of mistakes were made and some new facts learned, to which attention is invited. The subsoil in this region is composed of disintegrating volcanic ashes. It is of a clayey nature and will neither absorb water nor drain. This makes the deep drainage ditches unnecessary. The broad, flat ditch has proved itself equal to every emergency. On a portion of the road 1.2 miles in length, with no outlet for this distance, with the adjacent country all draining into the road, the ditch of the type designed by Lieutenant Caples, and approved by Lieutenant Pillsbury, handled all the water during the heaviest rains and discharged it promptly through a culvert at the end of the slope. The deep drainage ditches on other portions of the road caved in, became clogged, and overflowed the road.

27. An unmetalled earth road or one metalled with tufa cannot withstand the rainy season. During the spring of 1902 the entire road from Tanauan to Lipa was graded and the sub-grade prepared for receiving the metal. The unmetalled portion was a perfectly shaped earth road. The drainage system was complete. Traffic passing during the early rains cut little ruts not over half an inch deep. These held water because the subsoil would not absorb it. More traffic over the ruts full of water cut in deeper. By the end of the rainy season the road was uniformly muddy and cut out of its former shape and had to be reshaped this year. However, it was passable all season, and the mud holes and great bogs of former seasons did not appear, showing that the nature of the soil, not the drainage system, was at fault. The same results were obtained on other parts of the road. It is considered necessary for economical work not to carry work on the shaping of the sub-grade more than one-quarter of a mile ahead of the work of laying metal. The so-called "adobe stone," which underlies all this country, is a semi-metamorphic volcanic tufa. It is used by the natives as a building stone. Placed on a road in the dry season and well tamped it offers a smooth, resilient surface, and wears well so long as the dry season lasts. The compactness of its surface and its slight absorbent power, leads one to believe that it would shed water and be a good metal. It is too soft. Several miles of it were placed and before the end of the rainy season the tufa had all become a mud of the consistency of half-set cement. If the ruins of old buildings can be obtained, the lime in them binds the tufa and offers a wearing surface that will permit of metalling during the rainy season, provided it is subject to no other traffic. A fill of this nature, made between Lipa and San Jose during the dry season of 1902, accomplished its object. Where metal is scarce the tufa is useful in permitting the top dressing to be about one-half its ordinary thickness, for so long as actual wear is not placed on the tufa, it makes a cheap and excellent foundation. This fact was taken advantage of on 17.5 miles of the road.

28. Two new road materials were found and used. Almost all sand is round and unfit for road metal, but two varieties were found here which give excellent results. The streams from the mountains rush down very steep slopes to the plains. Here they deposit in large beds a mixture of three-fourths sand and one-fourth gravel. The short distance this sand is carried does not allow it enough wear to become rounded. The mountains are all extinct volcanos and composed of the best road building rocks. The material from these beds of sand and gravel was found by experiment to have the property of packing. A street built in Calamba

during the rainy season of 1901 and 1902, was difficult to break with a pick, and to-day, with no repairs since it was built, it has the appearance of a solid mass of stone, hard as the best macadam and smoother. After leaving the plain and approaching the mountains no sand or gravel was found in the river beds, because the force of the water kept them scoured. No material was at hand and it was too far to haul. While reducing a grade by cutting, a pocket of black sand, turning gray upon exposure, and half full of scoria and dust was encountered. This was tried and found to pack. A comparison with the cinders on the volcano of Taal showed this material to be volcanic cinder, thrown out during some previous eruption and now in process of disintegration. Investigation of the country showed that this cinder occurs in a layer from 2 to 40 feet thick and from 10 to 50 feet under the surface of the earth. Outcrops in ravines are the cheapest and easiest to work. This makes only a fair road material because it wears and washes about an inch a year under traffic, thereby necessitating annual renewals. It was used on 21 miles of the road because no better material was obtainable. The best metal, where it can be obtained, appeared to be crushed trap rock, 4 parts, intimately mixed with crushed coral, 1 part, the mixture laid 8 inches thick and covered with 2 inches of the scoria sand from the pits. The crushed coral and the sand in addition to just filling the voids in the trap rock, have a cementing effect which causes this type of metal to combine the advantages of the smooth, compact coral rock with those of the hard, durable trap rock road.

29. Timber can not be used to advantage in road structures in this region. That the Spaniards had learned this is evidenced by the absence of all wood in their road structures. We did not profit by their example. The best creosoted Oregon pine will not last over a very few years, most of it rotting in less than two. It will do well enough for hastily opening a line of supplies or for structures needed for a short campaign, but where permanent work is to be done here only stone or steel is recommended. For cheap work tufa blocks in lime mortar will do, if protected from wear by some other material. Cement mortar with tufa blocks is extravagant. For thoroughly good work it is believed that steel and concrete would be the proper materials for road structures.

Very respectfully, your obedient servant,

W. G. CAPLES,

2d Lieut., Corps of Engineers.

REPORT

UPON THE OPERATIONS OF THE 1ST BATTALION OF ENGINEERS

IN CONNECTION WITH

THE MANEUVERS AT FORT RILEY, KANSAS, SEPTEMBER AND OCTOBER, 1902.

SMITH S. LEACH,
MAJOR, CORPS OF ENGINEERS, U. S. ARMY, COMMANDING.

PRESS OF THE ENGINEER SCHOOL OF APPLICATION,
WASHINGTON BARRACKS, WASHINGTON, D. C.
—1903—

No. 6.

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—1903—

REPORT OF MAJOR SMITH S. LEACH, CORPS OF ENGINEERS, U. S. A., COMMANDING 1ST BATTALION OF ENGINEERS.

HEADQUARTERS, 1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANSAS,
MARCH 26, 1903.

BRIGADIER GENERAL GEORGE L. GILLESPIE,
CHIEF OF ENGINEERS, U. S. ARMY,
WASHINGTON, D. C.

(Through Military Channels.)

GENERAL:

1. Referring to Department Letter of September 23, 1902, No. 44257, I have the honor to submit a report upon the participation of the 1st Battalion of Engineers in the maneuvers at Fort Riley during September and October of last year. This report contains, either in its body or in the form of appendices, copies of all reports I have submitted in regard to the maneuvers and also of all reports I have received on the same subject from my own subordinates. This report and its appended documents is designed to place in the possession of the Chief of Engineers the fullest information obtainable as to the class of duties and responsibilities placed upon engineer officers and troops during the maneuvers at Fort Riley and on the march thither from this post and return; as to how the new equipment and material fulfilled the purposes for which they were designed, and as to the additional equipment which should be prepared or purchased with funds now, or to become, available.

2. The participation of the battalion in the Fort Riley maneuvers was required by General Orders No. 96, Adjutant General's Office, 1902. General Order No. 34, Headquarters, Department of the Missouri, 1902, provided that "The troops from Fort Leavenworth will proceed by march-

ing, and all riding animals and wagon transportation not essential for post needs will be taken with the commands. Ponton material and heavy baggage, including clothing, wall tents and conical wall tents, in excess of what can be conveniently carried in wagons will be shipped by rail. These commands will reach Fort Riley on or about September 20, 1902." In General Orders No. 38, Fort Leavenworth, Kansas, September 3, 1902, the battalion was ordered to proceed by marching to Fort Riley, Kansas, on September 8, 1902. A contract surgeon, one non-commissioned officer and four privates of the Hospital Corps were assigned to duty with the battalion for the march.

3. General Order, Headquarters, Department of the Missouri, No. 34, afore stated, provided further: "Marches will be conducted as if in the enemy's country, and instructions and exercises given in all the ordinary measures for the safety of the command, such as advance and rear guards, patrols, flankers, and at night outposts, etc. An itinerary and map of the route travelled will be prepared by a competent officer and submitted to these headquarters."

4. The details of breaking camp, forming for the march, etc., were covered by Battalion General Order No. 74, dated September 5, 1902, as follows:

HEADQUARTERS, 1ST BATTALION OF ENGINEERS,
CAMP LUDLOW, FORT LEAVENWORTH, KANSAS,
SEPTEMBER 5, 1902.

GENERAL ORDERS NO. 74.

The following instructions are published for the information and guidance of Company Commanders in carrying out the provisions of General Order No. 34, c. s., Department of the Missouri, and General Order No. 38, c. s., Post of Fort Leavenworth, Kansas.

1. On Monday, the 8th inst., calls will be sounded as follows:

Reveille, 5.15 A. M.; assembly ..... 5.30 A. M.
Mess call ..... 5.45 A. M.
The general ..... 6.15 A. M.

Formation of the battalion for the march:

First call, 9.30 A. M.; assembly ..... 9.40 A. M.
Adjutant's call ..... 9.45 A. M

Upon the sounding of "The General" tents will be struck. All tents to be shipped by rail will be folded and packed for shipment, and hauled to the depot for loading. Immediately upon the return of the wagons, they will be loaded, and the companies prepared for the march.

2. The uniform for the march will be: Campaign hat, khaki coat and trousers, leggins, tan shoes and blue shirt. Each mounted man will carry carbine in scabbard; revolver in holster on belt; canteen, tin cup,

nose bag and lariat, attached to saddles; blanket roll containing shelter tent half, pole and pins, one or two blankets, two towels; in saddle bags, one suit underwear, one pair socks, one chambray shirt, mess kit, soap, comb and brush, tooth brush, curry comb and brush; and one poncho to be carried as desired; pipes, tobacco, etc., if desired.

Each foot soldier will carry carbine and belt; canteen; tin cup attached to belt; blanket roll containing one or two blankets, one shelter half, pole and pins, two towels, one suit underwear, one pair socks, one chambray shirt; haversack containing mess kit, soap, comb and brush; poncho to be carried as desired; pipes, tobacco, etc., if desired.

Color sergeants, equipment of foot soldier, substituting color and sling for carbine.

Each company will carry 100 rounds ball carbine ammunition and 20 rounds ball revolver ammunition; this ammunition will be kept by first sergeant and issued to members of the guard as required.

3. Each man will prepare for shipment the following articles: One suit khaki (coat and trousers), one suit blue (coat and trousers), one extra pair shoes, one pair white gloves, two or three suits of underwear, two or three pairs socks, two or three shirts (chambray or blue). Such men as have sweaters may ship them.

These articles will be prepared for shipment, and hauled to the levee storehouse to-morrow (Saturday afternoon) before four o'clock.

4. Company Commanders will send in to the Post Adjutant with their morning report on Sunday, one ration return for 6 days from and including the 8th and one ration return for 6 days from and including the 14th. On the first will be noted that 1 days' soft bread, 5 days' hard bread and 3 days' bacon are desired, and 1 days' fresh beef to be drawn Monday morning; on the second will be noted that 2 days' flour, 4 days' hard bread, and 2 days' bacon are desired.

Fresh beef will be shipped to the following places:

Winchester, September 10th; Kilmer, 12th; Topeka, 13th; St. Mary's, 15th; Wamego, 16th; Eureka Lake, 18th. The first 6 days' rations will be drawn on Sunday; the second 6 days' rations will be received by rail at Topeka.

Each company will be equipped with two Buzzacott field ovens; and will carry in company wagon two wall tents and one conical tent with sibley stove. An additional conical tent may be carried if transportation is available.

5. In addition to the sick and the post extra and special duty men, the following men of the battalion will be left behind: Sergeant Costello, Company "A" on special duty in Dept. of Eng'ing, G. S. and Staff College.

For guard at Camp Ludlow:

Corporal Murphy, Company "A,"
Private Cluckauf, Company "B,"
Private Royce, Company "C,"
Private Stone, Company "D."

For guard at barracks:

Private King, Company "A,"

Private Geiser, Company "C."

For gardeners:

Private Ernst, Company "A,"
Private Ingle, Company "B,"
Private Martin, Company "C,"
Private Mitchkie, Company "D."

6. Lieutenant H. Burgess, Corps of Engineers, Adjutant, will, in addition to his other duties perform the duties of Battalion Quartermaster and Commissary.

Lieutenant N. E. Bower, Corps of Engineers, is detailed as topographical officer.

Q. M. Sergeant Peter W. Way, Company B, will act as Battalion Q. M. Sergeant.

7. The daily order of march will be:

First.—A mounted detachment as advance guard and reconnoissance party.

Second.—The battalion of unmounted companies.

Third.—The bridge, wagon and pack trains, escorted by a mounted detachment.

Fourth.—A mounted detachment as rear guard, provost guard and reconnoissance party. The commanding officer of this detachment is especially charged to see that all camping grounds are left in proper condition, and that no damage is done to private property on the march. He will immediately report to the Battalion Commander by courier any circumstance which, in his opinion, might give rise to a claim against the United States.

8. The mounted detachments will rotate alphabetically in the three positions described in the preceding paragraph, beginning with the mounted detachment of Company "A" in advance, of Company "B" as rear guard, and of Company "D" as train guard.

The train guard for each day will furnish orderlies for the Battalion Commander and Adjutant, couriers and special details of mounted men not otherwise provided for. Its commanding officer will immediately notify the Battalion Commander by courier in case of any delay to the trains.

BY ORDER OF MAJOR LEACH:

H. BURGESS,
1st Lieut., Corps of Engineers,
Adjutant.

The column was formed as indicated in the order and put in march at the time stated. On making first camp the requirements of the Department Order as to security and information were met by the establishment of two mounted pickets on the roads leading to camp, which were placed by the advance guard before the battalion left the road. These were relieved at two hour intervals from the section which had acted as advance guard, until 6 P. M., at which time a guard was posted as provided by the following memorandum:

MEMORANDUM.

There will be a running guard of four non-commissioned officers and eight privates from each company. Company A behind Headquarters, Company B in road, Company C behind wagons. Men to sleep in their companies, and to be turned out for 1½ hour tours. Non-commissioned officers to take two tours of 1½ hours each.

Company D to furnish same detail, to be divided into two pickets of two non-commissioned officers and four privates. Posted on road in advance, and in rear, about ½ mile from camp and to be on from 6.00 P. M. to 6.00 A. M. Non-commissioned officers and privates divide up the time.

The senior non-commissioned officer of each company will report to Captain Flagler, Officer of the Day. The stable guard will be furnished by the mounted detachments.

BY ORDER OF MAJOR LEACH:
H. BURGESS,
1st Lieut., Corps of Engineers,
Adjutant.

5. At the close of the second day's march it became evident that the pack train was a troublesome element in the position first assigned to it in the column, and the next morning it was placed in the rear of the bridge train with only the rear guard behind it. The experiences of these two days' march were embodied in the following memorandum dated September 9, 1902:

MEMORANDUM:

1. Hereafter as soon as shelter tents are pitched four men from each company will report to Sergeant Dolan to dig sinks; four men from each company as heretofore ordered, to report to Sergeant Hurtt for Headquarters. This detachment will also provide wood and water for Headquarters, but will not cut wood, etc.

2. Lieutenant Bower—when A Company detachment is with train—will turn over detachment to senior sergeant and will take command of B Company detachment as the advance guard.

3. The detachment which is acting as train guard will ride at head of train of company wagons; but will keep four men at the rear of the foot command, one of whom will remain at any cross road passed to indicate to wagon train which way to go. Any men so left, may rejoin the foot command when the foot command is halted. The detachment acting as train guard will confine itself to the company and battalion wagons.

4. The advance guard will start out in the morning, as soon as the battalion is formed for the march; the wagon train will start 20 minutes after the foot troops; and the pack train 20 minutes after the wagon train. Company and battalion ration wagons will be at the head of the column of wagons. Company tool wagons will follow.

5. Upon arrival at camp the ration wagons will draw up at site of kitchen; Headquarters wagon at site of Headquarters, to stop where directed by the Sergeant-Major; tool wagons will park with bridge train,

unless a company commander desires his wagon at site of kitchen.

6. Mounted detachments will form their camp in front of picket line under direction of senior detachment commander. Pack mule picket line will be parallel to detachment lines and just inside so that one stable guard will do for both. Unless specially directed to the contrary, no part of camp will be outside of detachment picket line.

7. Q. M. Sergeant Dearborn will be acting Commissary Sergeant, and will be in charge of the issue of fresh beef and rations. Company Q. M. sergeants will report to him for instructions at Winchester and other places where fresh beef or rations are to be drawn.

8. Guards will be established on four sides of camp as at Lowemont and two pickets on the road. The mounted detachments will furnish the guard for their side of camp—a running guard of four non-commissioned officers and eight privates. The dismounted companies will furnish running guards as directed daily.

9. The pickets will be established by one of the unmounted companies as follows: Two non-commissioned officers and four privates in each of two outposts, one ½ mile from camp in advance and one ½ mile in rear of camp, in the same manner as at Lowemont.

10. The mounted detachment in the advance guard will, as soon as camp is reached, establish a single mounted picket ½ mile in advance of camp and one ½ mile in rear of camp. These posts to be relieved every two hours from same detachment, until relieved at 6 P. M. by pickets. These pickets may dismount, but will keep on the alert. The detachment commander will see to the relief of these pickets at proper times.

11. Stable call will be sounded morning and evening. The mounted men will fall in for reveille with their nose bags and curry combs and horse brushes, and will be marched to the picket line immediately after roll call. Approximate time for evening stables, 4.15 P. M. Exact time will be given from day to day by the Battalion Commander.

Animals will be watered in the following order: 1st, the mounted detachments, in charge of the stable sergeant; 2nd, the draft and train animals, in charge of Mr. Stone; 3rd, the pack animals in charge of Corporal Foster. Men in charge will see that the animals are watered with as little confusion as possible, and returned to the picket line with as little delay as possible to make way for other detachments.

BY ORDER OF MAJOR LEACH:

H. BURGESS,
1st Lieut., Corps of Engineers,
Adjutant.

A police officer was detailed to inspect the camp before the assembly to see that company streets and adjacent grounds were properly policed. The commander of the rear guard was also charged with the duty of making a minute inspection of the entire camp site, giving special attention to any disturbances of ground, fences or other property which could possibly be made the basis of a claim for damages. He was instructed to

see that all gates and bars were properly closed and that nothing was left in such situation as to give rise to reasonable complaint.

6. The order of march adopted remained unchanged until the last day. Upon leaving camp at Eureka Lake on September 19, 1902, the calls and order of march were arranged as indicated in the following memorandum with a view to entry into the maneuver camp. The service of security and information and the reconnoissance work were discontinued at the reservation line:

The following instructions are published for the information of the battalion.

Calls for To-Morrow.

Reveille, first call, 5.30 A. M.; reveille, 5.40 A. M.; assembly, 5.45 A. M.
Breakfast ..... 6.15 A. M.
Police call ..... 6.30 A. M.
General ..... 6.45 A. M.
First call, 6.55 A. M.; assembly ..... 7.00 A. M.

A and B Companies' mounted detachments will act as advance guard; A Company's detachment being the advance party, B Company's detachment being the reserve. The reserve will march 700 yards to 800 yards in front of the foot troops and will keep two or three connecting files to maintain touch with foot column. The support will be about 500 yards in front of the reserve, and the point 500 yards in front of the support. These bodies will keep in touch with each other and with the reserve by connecting files. Lieutenant Bower will command the advance guard.

The trains will start 20 minutes after the foot troops; followed at about 500 yards by the rear guard, consisting of D Company detachment commanded by Lieut. Knight.

Reconnoissance men may march anywhere between the point and the reserve.

When the point is in sight of camp it will halt and the column close up on it. When the column is closed, the following formation will be taken: 1st, battalion of unmounted companies in column of fours, officers and mounted file closers in the position prescribed in drill regulations; 2nd, the mounted company in column of twos 20 yards in rear of the battalion, commanded by the senior officer; 3rd, the wagon train, baggage wagons in front, 20 yards in rear of the mounted company; 4th, the pack train 20 yards in rear of the wagon train.

At this halt, special duty men will join their companies, and C Company will join the battalion; all men must carry their blanket rolls; colors will be unfurled.

By order of Major Leach:

H. BURGESS,
1st Lieut., Corps of Engineers,
Adjutant.

7. The camp site assigned to the battalion was near the Division Headquarters on the crest of a ridge near the main road. It was restricted in area, but would have been an excellent site in any ordinary weather. As the weather proved to be extraordinary, presenting almost incessant rain, and as the sinks were necessarily dug on the slopes of the ridge and on lower ground than the camp proper, it was found impossible to keep them clear of water at all times. This was the cause of some adverse comment from the Division Surgeon and medical officers of the day. The reports of the latter were, however, so contradictory as to deprive them of most of their weight. On one day the report stated that the sinks were entirely too far from the company streets; the next day's report, by another officer, stated that the sinks were entirely too close to the company streets, and such alternations of opinions were frequent. Some medical officers of the day reported the sinks in good condition. Others, acting under substantially the same conditions, reported them in bad condition. A special report, adverse to the condition of the sinks, was finally made by the Chief Surgeon, and was referred to me for action. Upon this report I placed the following indorsement:

"Respectfully forwarded. The conditions of this camp are well set forth in the within report.

The men's sinks are now and have at all times been in perfectly sanitary condition. The officers' sink has at times been unpleasant to visit; though not more so than the average public closet in the best regulated cities.

So far as I am informed, there has been no case of sickness in this battalion traceable to sink infection. There is no possible connection of the sink drainage and the water supply, and there have been no flies or mosquitoes about the sinks at any of my inspections.

The Division orders with regard to sink police have been scrupulously carried out and all informal recommendations of medical inspectors have been carried into effect except one requiring earth to be thrown in to absorb the water, and another requiring each man to cover his own deposit with earth before leaving the sink. I had tried both these things before this camp was established and know them to be wholly impracticable. The deposits which can be individually covered are not dangerous, and those which are dangerous can not be so covered.

I would much prefer quick to slacked lime for use in the sinks, but as the battalion has used open sinks continously since last April and has never been able to obtain a pound of quicklime, I conclude that there is some difficulty connected with its supply.

I deprecate the freer use of earth in the sinks as it is not necessary and will devolve upon men already worked to their full capacity the labor of frequently digging new ones.

I recommend that no change be ordered in the policing of the sinks of this camp.

SMITH S. LEACH,
Major, Corps of Engineers,
589–1902 Commanding 1st Battalion of Engineers."

No further communication reached me on the subject and no modification of the standing orders was made.

8. The camp routine was regulated by Battalion General Orders No. 78 as follows:

1. In compliance with General Order No. 3. Headquarters, Maneuver Division, Camp Root, Fort Riley Reservation, c. s., the following calls will be observed by this battalion until further orders:

Reveille, first call, 5.45 A. M.; reveille, 5.55 A. M.; assembly, 6.00 A. M.
Police ---------- 6.00 A. M.
Mess ---------- 6.20 A. M.
Stables, 6.50 A. M.; assembly ---------- 7.00 A. M.
Sick ---------- 7.05 A. M.
Water ---------- 7.45 A. M.
Drill call, 8.20 A. M.; assembly ---------- 8.30 A. M.
Mess ---------- 12.00 M.
Drill call, 1 P. M.; assembly ---------- 1.10 P. M.
Water and stable calls, 3.35 P. M.; assembly ---------- 3.40 P. M.
First sergeant's call ---------- 4.50 P. M.
Police, 4.55 P. M.; assembly ---------- 5.00 P. M.
Guard mounting, first call, 5.10. P. M.; assembly ---------- 5.20 P. M.

Parades when specially ordered.

First call, 5.15 P. M.; assembly ---------- 5.30 P. M.
Retreat, first call, 5.45 P. M.; assembly ---------- 5.55 P. M.
Mess ---------- 6.15 P. M.
Tattoo ---------- 9.00 P. M.
Call to quarters ---------- 9.45 P. M.
Taps ---------- 10.00 P. M.

All calls will be sounded first by the trumpeter of the guard at Division Headquarters, and upon completion of the last note, will be repeated in the various camps concerned.

When parades are held, guard mounting will immediately follow.

Formations at reveille and retreat will be under arms.

Companies will be inspected at retreat. A commissioned officer will be present in each company at roll calls.

Drills will be held when specially ordered by the Battalion Commander.

BY ORDER OF MAJOR LEACH:
H. BURGESS,
1st Lieut., Corps of Engineers,
Adjutant.

9. Careful attention was given to the matter of reconnoissance of the route of march, not only with a view to producing a proper map of the road traversed as required by Department General Order, but with the further object of ascertaining, if possible, how much work could be done without delaying the march of the column. This work was under the immediate direction of Lieutenant N. E. Bower, who was detailed as Topographical Officer. It is only just to say that the excellent results obtained were, in a considerable degree, due to the energy and efficiency of that officer. With a few exceptions, the reconnoissance work was done by mounted men. They were invariably sent out in pairs, consisting of an observer with the Cavalry Sketching Case and a timer whose business was to keep the time and give constant attention to the gait. The pairs had been timed for rate and a proper scale was used for each. It was found necessary to re-time on the march as the gaits of the animals changed slightly under the work of the march. Two odometers were used on the bridge train, and their readings were taken at the beginning and close of the march, the distance so determined being used as a check on the distances brought in by the main road parties. It was at first attempted to use the odometer readings as a means of adjustment, but the discrepancies between the readings of the two instruments, which should have been identical, and other irregularities soon indicated that quite as much reliance could be placed upon the sketching boards as on the odometers.

In round numbers 350 miles of road and the adjacent country on each side were sketched and mapped. The general arrangement of the party, as stated by Lieutenant Bower, was to put the best man on the main road and to detail one man to assign the other pairs to side roads. In addition patrols were sent out on long routes to bring in maps of adjacent and sometimes parallel roads. The second best men were usually placed on these patrols. All such sketches were properly marked so that they could be quickly placed when brought in.

As soon as camp was pitched the drawings were assembled in a tent set aside for this purpose and the map compiled. The compilation was done by taking the sketches off the boards, trimming them to proper size and shape and pasting them in their proper relative positions to a piece of drawing paper. The map could be put in fairly good form in two hours after the command arrived in camp, but frequently extra work was put on it in the way of extended areas of topographical signs, and the enlisted men who desired to do so were permitted to work until taps. It is to be noted that of over 300 miles of road actually mapped, all but three miles was done by enlisted men of this battalion. In compiling the map from the

sketches, the Topographical Officer gave his personal assistance, as well as supervision, and was voluntarily assisted by several officers and enlisted men.

The map as thus compiled at the close of the day's work was a pasted mosaic in pencil ready for reproduction. The latter could not be done on the march as no method had been worked out or facilities provided for doing it. The sheets were reproduced by tracing and blue printing during the stay of the battalion at Fort Riley and copies were submitted to the Division Commander. I invite attention to Appendix 1 to this report, embodying report of the Topographical Officer with his letter transmitting the same, and the indorsement of the Division Commander thereon. This map and Lieut. Bower's work in connection therewith were subjects of favorable mention in the report of the Division Commander to the War Department.

After the return of the battalion to Fort Leavenworth, the map was reproduced on reduced scale for more convenient use as a road map. There are enclosed with this report one set of blue prints,* in 11 sheets, of the route sketch made from Fort Leavenworth to Fort Riley and return; one set of blue prints, 3 sheets, of same sketch but on reduced scale; and blue print of reconnoissance sketches of Fort Riley reservation; one working sheet† showing method of joining together the pieces of work turned in by the different sketchers. The names of the enlisted men working on these sketches are given on plate 11. All the sketches were made with the Cavalry Sketching Case.

10. The report of the march to Fort Riley submitted to the Adjutant General of the Maneuver Division on arrival forms Appendix 2 of this report.

11. September 19th and 20th were occupied in making camp, ditching, digging sinks, etc. Sunday, the 21st, was also devoted in part to the same work. On Monday, September 22d, one company was engaged in constructing a road and bridge across the gorge of One Mile Creek, leading from the main road in a northeasterly direction to the Field Hospital, and materially shortening the distance from Headquarters to the Field Hospital and to some of the infantry camps. This work was continued on the 23d. A second company was assigned to the duty of making a hydrographic survey of the Kansas River through the limits of the reservation. A corporal and two privates were assigned to special duty as assistants to Major Macomb, Artillery Corps, Hydrographic Officer of the Maneuver Division. The survey of the river was continued as opportunity offered during the entire encampment, but on account of the rise of the river, run of drift, and pressure of other duties, and the lack

* Not printed. † Printed.

for most of the time of any boats which could be used, prevented any substantial progress although valuable instruction was obtained.

Company C was assigned to the unloading of ponton material shipped by rail, the assembling of the material at the river, and the construction of the bridge.

The fourth company constructed a bridge over Three Mile Creek on the main road to avoid fording by the foot troops. One Birago trestle and balks and chess for two bays were used. Approaches were cut to the bridge and the approaches to the ford for the use of wagons were also improved.

Company D also prepared near the camp specimens of trenches of various kinds, entanglements, etc., which were used to illustrate a lecture on the subject given by Captain Cavanaugh to more than 100 National Guard officers.

As men could be spared from time to time mounted reconnoissance parties were sent out on the various roads and trails of the reservation. This work was undertaken mainly for the purpose of instruction and demonstration, but it was immediately discovered that the existing maps of the reservation were not at all accurate, and this work was thereafter prosecuted with a view to obtaining material for their correction.

12. The various lines of work above noted occupied the companies assigned to them at all times when they were not participating in some of the maneuver problems. The battalion was called upon to take part in a majority of these problems. The entire battalion participated in the exercise of September 24th, forming a part of the blue forces under command of Colonel C. W. Miner, 6th Infantry. The problem consisted in the formation of an outpost for an army corps, with exercises in attack and defense of same, and the blue force had the defensive rôle. The foot sections under my own command, with the Battalion Surgeon and Field Hospital, were assigned to a position in the right center of the line, holding a bold hill lying between the two branches of Forsythe Cañon. Two mounted sections and the pack train were assigned to the extreme right as supports to the mountain battery and to assist it in intrenching. My report to the Adjutant General of the Blue Army, dated September 24, 1902, is given in Appendix 3. The report of the operations of the mounted sections was not made through me, but I have unofficial information that they rendered efficient service and that the equipment appeared to be in the main satisfactory. Only intrenching tools were taken in the canvas pouches made to ride on the aparejo. The mobility of the pack train and the ease and rapidity with which tools

could be gotten from the pouches and replaced seem to be all that could be desired.

13. In the problem of September 26th, which was the exercise of each infantry regiment as advance guard of an imaginary division involving the employment of artillery, one-half of Company A was assigned to the 6th Infantry; the other half to the 18th Infantry; the mounted section of Company B to the 22d Infantry. Company C and the foot sections of B and D worked on the bridge. No reports were made to me of the operations of the parts of the commands which participated in the exercise. Attention is invited, however, to the reports of Company Commanders on the general operations during the maneuvers which contain some information with regard to the movements of these parts. (See Appendix 7).

14. In the problem of September 27th, "the entire force on the march with suitable advance guard for a division of full war strength; advance guard entire; main body in part imaginary," the entire battalion participated as a part of the blue forces. The mounted section of Company B was assigned to the support of the van guard. The rest of the battalion and the light bridge train, tool wagons, and Battalion Hospital were assigned to the reserve. No orders were received further than those assigning the battalion to its position in the column. The line of march was followed part way through Governor Harvey Cañon, diverging near the head over a rough trail to the right. Shortly after leaving the main road the trail led up a steep ascent of about 50 yards over the rim rock, very rough and difficult. Some hospital wagons ahead of the battalion could not make the ascent and teams and men were sent forward to assist them. One company was detailed to improve the road, which was done by filling depressions with loose rock lying near and a little shoveling. The company was left to assist the bridge train over the difficult piece of road and the battalion moved forward. The trail led along the foot of a rather steep slope. No grading had been done and the trail consisted only of two wheel tracks in the grass. At one point the cross slope was so steep that the tool wagon upset. It was quickly righted, tools reloaded, and the march resumed, but enough time was lost to open quite a gap in the column.

No orders having been received, the battalion was assembled in a draw in rear of the deployed line and under cover, and messengers were sent forward to endeavor to find the Brigade Commander and ask for instructions. A few minutes later the Brigade Commander rode up to the battalion, asked how many mounted men there were, and on being informed ordered them put in the line on the right of the 18th Infantry. The

mounted sections were moved forward, dismounted under cover and deployed on the line. After inspection of the deployed line by the Division Commander, recall was sounded, the mounted detachments rejoined, and the battalion was marched back to camp. In passing Headquarters the column was reviewed by the Brigade Commander.

15. In the problem of September 29th, "contact of opposing forces of all arms," the entire battalion participated. Company C, under command of Lieutenant Burgess, was assigned to the support of the advance guard. The remainder of the battalion, with company wagons and hospital, formed the reserve of the advance guard. This problem was without special incident, as the part of the line in which the battalion found itself was at no time engaged. My report to the commander of the advance guard forms Appendix 4, and the report of Lieutenant Burgess upon the operations of the detached company form Appendix 5.

16. In the problem of October 6th, "attack and defense of a position," the entire battalion less one company (C) was engaged, the blue forces, defensive, in that problem being under my command. This exercise is minutely described in the report of the Chief Umpire, and nothing further seems to be necessary here, other than to refer to my report of the action to the Adjutant General of the Maneuver Division, which forms Appendix 6. Further details may be found in the reports of Company Commanders which form Appendix 7.

17. In the exercise of October 7th, "tactical exercise of a division," the battalion formed part of the blue force on the defensive. I was excused from participation on that day, and the battalion was under the command of Captain Zinn. The foot sections were put on the line at the extreme left of the blue force. The three mounted sections were united in a provisional company of two platoons, Lieutenant Pope commanding, and Lieutenants Knight and Bower commanding platoons. A detachment of about 12 men of the 8th Cavalry was attached to this company. The company formed part of the advance guard, and after the engagement opened, was broken up into patrols. An umpire informed me unofficially that one of the best pieces of patrol work he had seen during the maneuvers was performed on this day by a small mounted squad under the command of an engineer officer. It was evidently one of the patrols from this mounted company, but the name of the officer was not given.

18. On October 8th, part of Company B began the construction of a double lock spar bridge over a gully just east of Three Mile Creek. The rest of this company and Companies A, C and D dismantled the bridge, assembled the material, loaded the wagons, hauled them to the depot and

entrained. All of the material was loaded during the day except seven wagons. These were loaded early the next morning.

19. Orders were received from the Division Commander to turn eight escort wagons with teams and drivers over to the 6th Infantry for the return march, transportation to be re-transferred on arrival at Fort Leavenworth. The foot sections of the battalion were ordered to return by rail; the mounted sections and train, by marching. The Battalion Commander and Staff accompanied the road column. Camp was broken on the morning of the 10th, baggage loaded and foot sections entrained by 11.00 A. M., at which hour the mounted sections and train took the road for Fort Leavenworth. About a half mile from camp, the column was passed by the train containing the rest of the battalion.

On the return march, no security and information work was done. The train moved out of camp usually a few minutes after daylight, the rest following about 7:30 A. M., or from an hour to an hour and a quarter behind the train. Some reconnoissance work was done to fill in gaps left on the way over and to explore some alternative routes. Between Manhattan and Wamego, a road on the south side of the river was taken with a view to avoiding a heavy stretch of sand which was encountered on the outward trip. Very little was gained, however, as the southern road was heavy with mud. In a very dry season the southern road would be best, but at all other times the northern road is preferable. The road column reached Fort Leavenworth at 1.00 P. M. on the 17th, with men and animals in good condition.

EQUIPMENT.

20. The bridge train taken on the road consisted of one division of the light equipage, less the forge wagon which was sent by rail as there were not sufficient animals to draw it. Each wagon was drawn by four mules, driven with a jerk line. The material was of standard pattern, loaded as prescribed, except that the rigid splinter bars had been replaced by double and single trees and that lever brakes had been attached to all wagons except the tool wagon, these changes having been made under the authority of the Chief of Engineers. The brakes were intended to be operated by the teamster from his saddle on the near wheeler by a line attached to a brake lever of ordinary form. This arrangement, though practicable, gradually fell into disuse, since as no ambulance was provided, the men unfit for marching were compelled to ride on the wagons of the train and for obvious reasons were distributed as widely as possible, and it was soon found that the men riding on the wagons had relieved the teamster of the

duty of working the brake. The change in the draught rigging gave entire satisfaction, and I feel justified in recommending as the result of this experience that all the rigid splinter bars be replaced, as soon as possible, by double and single trees. Persons competent to express an opinion on the subject are of the opinion that the mules would have suffered severely on this march if they had been compelled to pull on rigid fastenings. As it was, there was not a sore shoulder or a collar mark, so far as my knowledge extends, when the train pulled into Fort Riley. The road test was not severe. Part of the route was hilly, but the roads, as a rule, were hard and smooth. Some difficulty was encountered from chess working out of place, the arrangement for holding them not appearing to be sufficiently positive.

As before stated, Company C was assigned to the bridge train for the maneuver period, and made the march over alongside the wagons. Captain Flagler, in command of this company, was constantly present with the train, and has submitted a very complete report, to which especial attention is invited. It forms part of Appendix 7.

In the exercise of September 27th, (paragraph 14 of this report), in dragging the train over the rim rock, as described, every one of the old pattern chess wagons, having a sort of crib work over the front bolster, was broken. The new model chess wagons, having a solid bolster and a steel plate for fifth wheel, proved entirely satisfactory.

21. On the return march the same train was hauled with the substitution of sound wagons for some of the broken ones, but a different loading of the ponton wagons, suggested by Mr. Stone, the Master of Transportation, was tried. A floor was made of the seven balk, the two side frames were placed on edge bottom up against the bolsters on either side, the ponton cover in its box, chess and small articles placed between. This load carried well and for this occasion had the advantage of forming a very convenient receptacle in the rear for such articles of baggage as it was necessary to put on the train, in view of the fact that our wagon transportation had been turned over to the 6th Infantry, and that the pack train was loaded mostly with tools. Some difference of opinion exists among the officers of the battalion as to whether this method of loading is superior to the old. I am not at present prepared to make a recommendation.

22. The construction of a bridge was begun immediately on arrival, and the constant rise of the river and heavy run of drift prolonged the work through the entire period of the maneuvers and gave the officers and men of the battalion a most valuable experience.

The rise in the river increased its width so much that, in order to span it, it was necessary to use all the wooden pontons and seven trestles. The men had had but little boat drill and exclusively in still water. I felt a good deal of concern as to what the results would be in attempting to handle boats in the swift current. I was surprised and gratified to find that little or no difficulty was experienced, the boats being handled with celerity and precision.

As the material used was of uncertain age and some of it apparently weakened by decay, I directed that seven balk should be used in each bay instead of five, and that all put in the bridge should be individually tested. The details of this work are described by Captain Flagler in the report cited. But few rejections were made, and if I could have known the result of the test in time, I would have had the bridge built with five balks instead of seven as it would have been amply strong.

23. The most important point developed was the adaptability of the Birago trestle for use in swift currents of considerable depths over a movable bottom. The trestles were strengthened when set, by a line from an anchor upstream leading to the upstream end of the cap and hauled taut. The object of this was mainly to cushion the impact of drift and it was very successful in that respect. It also relieved the trestle from severe cross strains due to the pressure of the current and drift and made possible the adjustment of height of cap. The rise of the river and the settlement of the shoes of several of the trestles brought the upper side of the roadway at one point under water. The urgency of the case made it necessary to try at least to raise the caps, and the trial was so successful as to lead me to believe that under any ordinary circumstances no difficulty will attend this operation. I am now of the opinion that no great sacrifice of weight or simplicity of the trestle should be made in order to introduce a facility of cap adjustment.

24. The pack train equipment consisted of aparejos and their accessories. As there were only three mounted sections, the "C" mounted section having not then been fully organized, the train was divided into three parts, each of identical organization, and one was assigned to each section to be taken out whenever necessary by the section, but concentrated on the march. Six canvas pouches, designed by the chief packer, were made before starting, arranged to go on the aparejo and to be fastened to it by straps which did not interfere with the opening of the flaps of the four pockets which each pouch contained. The lower pocket was long enough to take shovels and pick handles. The upper pouch was long enough to take picks, bill hooks and other similar tools. The pouches

were of sufficient size to carry, when fully loaded with the average assortment of road and bridge tools, all that one mule could carry. These pouches gave great satisfaction, the only criticisms to be urged against them being that the material of which they were made was not suitable, and it was known not to be when it was used, and that the design was defective in some trivial details. The other packs were made up in the conventional way, the cargoes being arranged in side and top packs and put on with lair ropes and diamond hitch.

Not only did the pouches require less time to load in the morning and unload at night, but no case is known of a pouch requiring attention from the packers on the march, while on the other hand, the pack train could scarcely be approached at any time without some of the packers being found dismounted readjusting some of their packs. About half an hour or three-quarters after starting in the morning a majority of the packs required readjustment, and the march of the train was delayed several minutes to permit this. Considered merely from the standpoint of a loading device, the pouch is much superior to the diamond hitch and should be preferred whenever it can be used. There was frequent occasion to open a pocket, take out some tool, use it for a few minutes, and replace it, in which operation no other part of the load was disturbed and no time was lost in re-packing.

Based on this experience, an attempt is now being made to extend the same principle to boxes of standard size, so arranged on the aparejo that they can be unlocked and opened without disturbing the fastenings to the saddle.

25. The wagon transportation consisted of the escort wagons supplied by the Quartermaster Department of which there were two for each company, the scheme being that one should be used for rations and baggage and the other for tools and engineering supplies. The result was that in most cases the two wagons were used indiscriminately for the two purposes and the loads were very much mixed. This was more or less of a necessity since both wagons had to be loaded to the tops of the bows in order to carry the material which had to be transported, and it seemed almost necessary to make the top loads of both wagons out of the lighter and more bulky materials and the bottom loads of the heavier stuff, and in its practical importance this classification seemed to outweigh the original one of baggage and tools.

The question of the suitability of the escort wagon for transportation of baggage and rations does not fall within the scope of this report. As to its adaptability for carrying engineer tools, the result of this experience

is, on the whole, unfavorable. The rigid sides of the wagon are not high enough to retain the loads properly. It is difficult to pack tools, especially edged tools, so that they will not be injured in transportation by rubbing together. It is not practicable to arrange loads so that the tools wanted at any particular time can be gotten out without disturbing the rest of the load, and finally, but by no means least in importance, engineering tools and supplies in the ordinary escort wagon are not secure from the weather and from trespass. A special tool wagon seems to be required and two designs are now under experimentation by two companies of the battalion and a third is proposed and will soon be constructed for trial.

The Headquarter's baggage, mess outfit, tentage, and photographic, draughting, and map-making outfits were transported upon a large six-mule stake wagon which was constructed by enlisted men of the battalion from the Quartermaster's scrap heap. This wagon was the most serviceable one we had as regards convenience of loading and unloading and freedom from shifting of load during the march. Time did not permit any systematic packing of the photographic, draughting, and map-making outfits. They were mainly taken in the boxes in which they were received from supply houses and other sources. The obvious inadequacy of this arrangement makes it unnecessary to comment further upon it. The photographic and map work was in the immediate charge of the Adjutant of the battalion, whose report thereon, containing some suggestions as to arrangement and packing, will be found in Appendix 8.

26. In the following recommendations of Company Commanders on the subject of equipment, I concur and recommend that steps be taken to make them effective.

By CAPTAIN FLAGLER:

That all wagons be equipped with single and double trees and brakes.

That one of the boathooks prescribed for each ponton be made sharp on hook and point, similar to log hooks, for convenience in handling the drift.

That each company be provided with 12 oil skin coats and hats and 24 pairs of fishermen's rubber boots.

That a suitable block and fall with slings be provided for raising and lowering trestle caps without dismantling bridge.

That the top of a trestle leg be modified in form to stand continued blows of maul without brooming and splintering. When the trestles are wet, it is found that considerable driving on legs is required.

That four false legs be supplied with each trestle.

By CAPTAIN FLAGLER and LIEUTENANT STICKLE:

That each division of the bridge equipage be supplied with a small boat for general work, such as soundings, life saving, etc. A suitable boat for this purpose is described in some detail by Captain Flagler.

By CAPTAIN CAVANAUGH:

The addition to the organization of the battalion of a veterinary with the rank and pay of sergeant, to perform also the duties of stable sergeant; a farrier and horseshoer for each section, to have the rank and pay of corporal, and the enlistment of special men as teamsters for the bridge train, with such compensation as will make their emolument equal to that of civil employes doing the same work.

26. The site of the bridge, cross sections of the river, elevation of the trestle end, and sketches of the cap-hoisting device, and proposed modifications to trestle leg, accompany the report of Captain Flagler.

Very respectfully,

SMITH S. LEACH,
Major, 1st Battalion of Engineers.

APPENDIX NO. 1.

CAMP ROOT, FORT RILEY, KANSAS,
SEPTEMBER 22, 1902.

THE ADJUTANT,
1ST BATTALION OF ENGINEERS.

SIR: I have the honor to submit herewith my report and itinerary as topographical officer for the march from Fort Leavenworth to Fort Riley, Kansas.

I forward also the maps compiled from sketches made by the enlisted men of the battalion, in eleven sheets.

Very respectfully,

N. E. BOWER,
2d Lieutenant, Corps of Engineers,
Topographical Officer.

GENERAL REPORT OF THE MARCH FROM FORT LEAVENWORTH TO FORT RILEY, KANSAS, SEPTEMBER 8 TO SEPTEMBER 19, 1902.

Being a summary of the daily reports.

The roadway. The road is the ordinary country road. It is fenced off into three widths, 30 feet, 40 feet, and 60 feet. As a rule but one track of about 9 feet width has been used.

The remainder of the roadway where the road machine has not been used recently is grown up with weeds, sunflowers, or sometimes underbrush. Teams can pass anywhere excepting on bridges, but it would scarcely be advisable to move two abreast even on the best portions excepting in emergencies. In some places recent repairs have been made, but for the most part few repairs have been made in the past year. The numerous hills materially aid drainage, and these with the existing side ditches keep the road in fair condition. The road is hilly from one end to the other. Only two marches may be said to have been made on level road, viz, from Reform Farm to Silver Lake and from Silver Lake to St. Marys, a total distance of 26.42 miles. The roadway, previous to reaching Reform Farm, is, however, much more hilly than afterwards. The worst portion of road is two miles on either side of St. George. This portion combines hills with deep sand, making marching difficult, but the advance guard bridge train was taken through with two mule teams per wagon without difficulty. The nature of the soil is such that deep washouts or gullies at right angles to the road are numerous, causing much bridging. Low portions of the road would give difficulty in very wet weather.

Bridges.

All large bridges, with two exceptions, are of steel or iron. The small bridges are of wood. As a rule they are in good repair and sufficiently strong for all ordinary loads. Their height is, with few exceptions, in the small bridges, above the high water mark. A few large bridges have pile piers or abutments, the rest have stone.

Cities.

These vary in size from 50 (Lowemont) to 3,500 (Manhattan). Topeka has 40,000 population, but was not passed through. Frame buildings are used throughout up to Reform Farm. Beyond this a good building stone is easily gotten and consequently many stone buildings are found in the towns and villages. Manhattan is a marked example of a city built in the neighborhood of good building stone. Every place has at least one railroad passing through. Telegraphic and telephonic com-

munication is easily gotten to all points, and rural delivery prevails throughout.

Streams. Streams are found in sufficient number to insure water for a command however large passing through. After passing Reform Farm the Kansas River is nowhere more than two or three miles distant and in many places close to the road. The banks of all streams and of the Kansas River in places, is uncleared land and hence they can be located a long way off.

Country. The country may be said to be hilly throughout, including the reservations at the termini of the route. The lay of the land greatly favors the defensive. The roadway usually visible from not far distant hills. The land is practically all farm land and hedge and wire fences are everywhere used. Corn is very extensively planted. The appearance of the crop indicates a very productive soil. Large orchards here and there show a heavy yield of apples this year. Hay can be easily gotten along the route. From one point about 3 miles north of Meriden 28 hay stacks were counted. Views of 15 or 20 miles are occasionally gotten from an eminence, but usually 3 or 4 miles is the limit.

Camping grounds. Camping grounds were hired in advance for the command and fuel, hay and grain were purchased from nearby farmers and delivered at the camp grounds usually before it was reached. The places chosen were some excellent, some quite poor. A total distance of 4.7 miles was lost in going into camps selected off the main road. Camp grounds were hired at all places excepting at Kilmer where a railroad siding was occupied. Water was always found in abundance and was generally good.

Railroads. Railroads were found in all the towns passed through giving connection with Leavenworth or Kansas City. The maps give these roads wherever they were found.

Telegraph lines. Telegraph lines in general are along all the roads passed over.

DIARY.

The command comprised the 1st Battalion of Engineers, with the advance guard bridge train and the

pack train. A detachment of the Hospital Corps accompanied. Leaving Fort Leavenworth at 9.55 A. M., September 8, 1902, Fort Riley was reached at 10.45 A. M., September 19, 1902. The total distance marched was 143.86 miles. Number of days marching, 12; average distance per day, 11.99 miles. The shortest march was 7.12 miles and the longest 15.94 miles. On the longer marches a stop of about 1¼ hours for lunch was taken. The total distance lost in going into camps was 4.7 miles. The total distance lost in taking wrong roads was 3.25 miles. The total distance therefore might have been reduced to 135.91 miles.

The command would start in the morning at hours designated by the Commanding Officer the preceding evening. The time varied between 6.30 A. M. and 7.30 A. M. The order of march was as follows:

The advance guard (one mounted detachment after the reconnoissance men had been taken away); three dismounted companies; one mounted detachment as train guard; the wagon train, followed by the bridge train; the pack train; the rear guard (one mounted detachment). The wagon and bridge train started twenty minutes after the dismounted men, and the pack train twenty minutes later. Halts were made by the dismounted men after every fifteen minutes of marching and the teams would catch up with them at the end of the second or third halt.

The weather previous to and on the march was dry. Two light showers on the march had no effect on the roads.

NOTE.—Errors have doubtless crept into this report and into the map work, but every possible care has been taken to make both as nearly correct as possible.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

EXPLANATION SHEET.

(To accompany report.)

Grades.

Grades in maps are expressed in degrees. The top and bottom of each hill is marked by a line at right

angles to the road, and an arrow between these lines shows the direction of water flow.

Numbers. Numbers inclosed in circles correspond to numbers in written report of bridges.

Numbers inclosed in squares correspond to numbers on the same sheet and show who made the drawing on which they were placed.

Letters. Letters on drawings correspond to letters in written report.

Main road. The main road is distinguished by having no numbers in squares on any of its pieces.

Distances. Distances were taken by odometers and the reconnoissance parties got their distances by the time method.

To obtain distances by the former odometers were put on both front wheels, and the average number of revolutions and the average circumference of the wheels used to compute the distance.

In the latter case the best results were gotten by timing the horses in pairs, and having a paper scale made and pasted on the rule of the sketching case.

Sketching case. The Cavalry Sketching Case was used exclusively.

Method of getting and using sketches. The reconnoissance party, consisting usually of four or five pairs, started out just before the column. The best man was given the main road and usually one man detailed to assign the other pairs to side roads. Proper marking was put on all side sketches so that they could be quickly placed when brought in. In addition, patrols were sent out on long routes to bring in maps of adjacent and sometimes parallel roads. This brought in much valuable information, as the maps attest. The second best men were usually placed on these patrols.

Compiling. As soon as camp was pitched the drawings were assembled in a tent set aside for this purpose and the map compiled. The map could be put in fairly good form in two hours after the command arrived at the spot, but frequently extra work was put on them and the enlisted men were permitted to work till late in the evening. All the outside work excepting about 3 miles of over 300 miles of road was done by enlisted men. They were used frequently in helping compile the maps

and put finishing work on them, which they did cheerfully.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT No. 1.

Fort Leavenworth to Lowemont, Kansas, September 8, 1902.

I. The roadway.

The road is the ordinary dirt road, fairly well drained by throwing or scraping dirt from the gutter to the center. No repairs, however, seem to have been made recently. For about 3 miles the width is 30 feet, after that, 60 feet Stone for repairs is not near at hand, but forest timber sufficient to corduroy wet places can be gotten conveniently. All grades are given in accompanying map. About 1½ miles from Fort Leavenworth there are two railroad cuts near the road and close to each other; depth, about 30 feet, and adjacent hills thickly wooded; timber generally small. Fences are all barb wire, excepting about one mile of hedge.

II. Bridges.

(1) One queen post truss steel, 30-foot span, 8 feet above water. Stone abutments; single track width and of ordinary strength; in good repair.

III. Rate of march.

Time, 9.55 A. M. 2 P. M.; distance, 8.87 miles.

Villages.

Lowemont. Lowemont is a country village of 50 people. A church at this place is visible 2 miles before reaching it. Principal buildings are post-office and telegraph office, and Atchison, Topeka and Santa Fe Railroad depot, and a small store.

Streams.

The only stream of any importance is Salt Creek. This is small and the water is unfit for use: width, 4 feet; depth, 1 foot.

Country.

The country is hilly the entire distance and greatly favors the defensive. Wooded spots here and there would afford concealment for large bodies of troops. Soil good. Plenty of corn and hay. Several newly ploughed fields would make travel in fields difficult but

for short distances only. A view of many miles gotten when near and at Lowemont.

Camping grounds. Very good at Lowemont. No good places for large command intermediate on account of scarcity of water. A grove about 3 miles from Fort Leavenworth large enough for two regiments to camp. Water would have to be gotten at farmhouses. Water at Lowemont was gotten from ponds and railroad station-house.

Railroads. See maps.

Telegraph lines. After passing railroad cut, 15 wires to Lowemont; usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 2.

Lowemont to Easton, Kansas, September 9, 1902.

The roadway. Country road, varying between 20 and 60 feet in width as fenced off, but scarcely ever more than 9 feet can be called road. The rest would require much work to make it passable. All grades given in accompanying drawing. Attention is invited to several hard grades in this march. Timber for repairs easily gotten. Hills give good drainage of one kind. Road scraper was used recently on part of this road. One-half mile east of Easton is a defile one-third mile long. High and heavily wooded flanks and bad road through it.

Bridges. The following bridges were found on the march:

1st. Wood; 8-foot span, 6 feet high; stone abutments; 2 x 10 inch balk and logs; 1½ inch and 2 inch plank; cross gully; condition good.

2d. Wood; 10-foot span, 6 feet high; stone abutments; 2 x 10 inch balk and logs; 2 inch plank; condition good.

3d. Four plank wide; 4 feet high; condition good.

4th. Wood; 8-foot span; 3 feet high; stone abutments; same material as second; condition poor.

(2) NOTE.—This bridge broke down under the advance guard bridge train.

5th. Wood; three plank; 2 feet high.

6th. Wood; 110 feet (paced); 25 feet above water; width, 15 feet; approaches of 30 foot and 20 foot spans;
(3) simple Warren truss; good stone piers; roofed.

7th. Wood; trestle bridge, two trestles, rotting; one
(4) post reinforced with plank; length, 40 feet; height, 25 feet; width, 15 feet; pile abutments; strength doubtful for siege guns. This bridge could easily be repaired or reinforced by timbers from adjacent woods.

Rate of march. Time, 7.40 A. M., 10.30 A. M.; distance, 7.12 miles; teams must march single; two abreast only after much road work.

Villages. Easton; population, 400; principal buildings, Leavenworth, Kansas and Southwestern Railroad station, post-office; telegraph and telephone to all points; three grocery stores, two hardware stores, two blacksmiths and wagon makers. This place would be difficult of defense, as it lies in an amphitheater, surrounding hills being close.

Streams. Big Stranger Creek; width now, 15 feet; very muddy; slow current; steep banks, giving considerable depth when high.

Country. Greatly favors the defensive; soil very fertile; corn is the principal crop raised. A view of about 10 miles is gotten to either side of the road almost the entire distance. Large fields of kaffir corn were passed. All arms could operate in this region.

Camping grounds. At Easton, water was gotten from a branch of the Big Stranger Creek. Farm house wells would have to be depended on at intermediate stopping places. Otherwise suitable ground in many places.

Railroads. Leavenworth, Kansas and Southwestern Railroad, given on map.

Telegraph lines. None on road.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 3.

Easton to Winchester, Kansas, September 10, 1902.

The roadway. Usual dirt road; the first two miles 30 feet wide, after that 40 feet wide; entire width passable and well drained,

excepting for short distances; road machine used; road now in good condition. Of the two roads at A, the one to the left is very hilly and should not be taken in preference to the one straight ahead; heavily wooded on part of flanks; road not specially good here. A defile one-half mile long at B; steep hills and bad roads: barbed wire used extensively for fences.

Bridges. The following bridges were found:

(5) 1st. Queen post truss; wood; span, 30 feet; height, 10 feet; width, 12 feet; pile abutments; condition good.

2d. Wood; span, 12 feet; height, 6 feet; width, 12 feet; condition good.

3d. Wood; span, 15 feet; height, 8 feet; width, 12 feet; pile abutments; condition good.

4th. Wood; span, 6 feet; height, 5 feet; width, 12 feet; condition good.

5th. Wood; span, 4 feet; height, 5 feet; width, 12 feet; condition very poor.

6th, 7th. Wood; span, 8 feet; height, 8 feet; stone abutments; condition very poor.

8th. Wood; four plank; 1½ feet high; condition good.

9th. Queen post truss; braced; wood; span, 30 feet;
(6) approaches, 8 feet; height, 10 feet; pile piers and plank abutments.

10th. Bowstring girder; span, 50 feet; height, 10 feet; steel pile pier on one side and pile abutments
(7) other side; 8-foot approach.

11th. Wood; six plank; height, 2 feet; condition poor.

12th. Wood; span, 8 feet; height, 6 feet; condition good.

13th. Wood; span, 6 feet; height, 6 feet; condition good.

14th. Wood; four plank; height, 1 foot.

15th. Stone culvert; two 18-inch pipe, imbedded.

16th. Wood; king post truss; span, 10 feet; height,
(8) 6 feet; condition poor, but piled under center.

Rate of march. Time, 7.35 A. M., 11.30 A. M.; distance, 10.33 miles.

Villages. Winchester; population, 600; frame buildings; Leavenworth, Kansas and Southwestern Railroad station; three hardwares and two blacksmiths; post-office; tele-

graph and telephone to all points; difficult of defense; adjacent country generally level.

Streams. Small, scarcely enough to water horses. Good water was gotten at Winchester camp from buried hogsheads.

Country. Good soil, very fertile, dark sandy loam. Corn and several large orchards; view of, perhaps, 20 miles to either side of road occasionally gotten; view of 6 miles frequently gotten; country more level than heretofore; timber is found only along creeks.

Camp grounds. Of all kinds, easily gotten, but farm house wells would have to be depended on for water.

Railroads. The Leavenworth, Kansas and Western from Easton to Winchester.

Telegraph lines. Two wire lines along road; usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 4.

Winchester to Osawkie, Kansas, September 11, 1902.

The roadway. Ordinary country road, but better than usual; two teams could move abreast after second half mile for several miles; the first half mile was unworn, but fairly good; all grades shown in map; view of from 3 to 4 miles is gotten on either side of the road; a bridge in course of building one-half mile west of Dunavant caused an extra march on the north road of about one-half mile; last half of distance, road is uncared for and unworn; barbed wire fences and hedge fences.

The bridges. The following are the bridges:

1st. Five-foot plank box; condition good.

2d. King post truss; span, 12 feet; height, 4 feet, above water; flankable stone abutments; doubtful
(9) strength, probably two ton the limit.

3d. Wood; span, 12 feet; plank abutments; condition good.

(10) 4th. Same as second.

(11) 5h. Bridge building here.

6th. Wood; span, 9 feet; height, 8 feet.

7th. Wood; span, 4 feet; height, 4 feet.

8th. Wood; span, 10 feet; height, 4 feet.
9th. Wood; seven plank; height, 4 feet.
10th. A-shaped bridge; height, 4 feet.
11th. Wood; eight plank; height, 4 foot.

Rate of march. Time, 6.55 A. M., 2 P. M.; one and one-quarter hour's stop for lunch; distance, 15.94 miles.

Villages. Dunavant, small country village of 70 population; buildings, blacksmith shop and lumber yard; Kansas City and Northwestern Railroad depot, four passenger trains daily; telegraph and telephone to all points; frame buildings, difficult of defense.

Streams. None of any importance; small ones shown in map.

Country. Generally hilly; at A-A large table lands or plateaus of striking appearance; the river valley stretches out in prominent view traveling from B to B; soil good and productive; corn the principal crop raised; farm houses scattered at intervals of miles and fractions of miles.

Camp grounds. A large body of men could encamp in the vicinity of Osawkie as the Delaware River would furnish ample water for all purposes except drinking, and numerous wells would supply this.

Railroads. The Kansas City and Northwestern Railroad at Dunavant, and the Leavenworth, Topeka and Southwestern Railroad at Osawkie.

Telegraph lines. Three wires from Winchester to near Dunavant, where six more wires join from the south; poles poor, of 5 inches diameter and bark on.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 5.

Osawkie to Kilmer, Kansas, September 12, 1902.

The roadway. Ordinary country road, varying in width 30 to 40 feet; road reasonably well drained and hilly; fences, barb wire and a few miles of hedge; all grades given on map; between Meriden and Kilmer the wrong road was taken, and this road was very poor and hilly; the proper road was reported much better.

List of bridges.

List of bridges:

1st. Bow-string truss, steel span, 125 feet; 30-foot
(12) approach; stone piers and abutments; height, 20 feet above water.

2d. Six planks; height, 3 feet; condition good.

3d. Three plank; height, 2 feet; condition good.

4th. Six plank; height, 2 feet; condition good.

5th. Four plank; height, 2 feet; condition good.

6th. Stone culvert over gully; 8-foot arch; condition good.

7th. Four plank; height, 2 feet; condition good.

8th. Wood; span, 8 feet; height, 2 feet; condition good.

9th. Wood; span, 6 feet; height, 2 feet; condition good.

10th. Wood; span, 4 feet; height, 4 feet; condition good.

11th. Wood; span, 8 feet; height, 8 feet; condition good.

(13) 12th. Warren truss; steel span, 80 feet; height, 20 feet; stone abutments. A 200-foot railroad trestle just north of this bridge; condition good.

13th. Wood; span, 8 feet; height, 8 feet; condition good.

14th and 15th. Four-foot boxes; condition good.

16th. Wood; span, 15 feet; height, 6 feet; condition good.

(14) 17th. Wood and iron queen post truss; 60-foot span; height, 20 feet above water; pile piers; condition good.

(15) 18th. Culvert, 40 feet; height, 12 feet; condition good

Rate of march. Time, 6.40 A. M., 12.20 P. M.; distance, 15.39 miles.

Villages. Osawkie; population, 300; post-office, telegraph office, one blacksmith shop, three hardwares; Leavenworth, Topeka and Western Railroad depot.

Meriden; population, 300; post-office, Atchison, Topeka and Santa Fe Railroad station, and a branch of the Leavenworth, Topeka and Southwestern Railroad depot, one blacksmith, two hardware stores, bank, livery stable; telegraph and telephone to all points.

Streams. Delaware River, 30 feet wide to 50 feet wide, depend-

ing on the weather. Rock Creek, width, 30 feet; very muddy; stream crossed by bridge (No. 14 on map), 40 feet wide; stream crossed by culvert (15) 6 feet wide.

Country. Hilly and under good state of cultivation; view wide; village of Rock Creek and dome of State capitol visible from point B on map; pyramid-shaped hill overlooking Meriden at C; wire and hedge fences used extensively.

Camp grounds. Suitable camp grounds could be gotten along the streams mentioned above.

Railroads. See map.

Telegraph lines. Two wires to Meriden; place for six more; usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 6.

Kilmer to Reform Farm, Kansas, September 13, 1902.

The roadway. Country road; fairly well drained and hilly, as shown on map; width, 30 to 60 feet; weeds and underbrush on either side of beaten path.

Bridges. List of bridges:

1st. Seven plank; height, 2 feet; condition poor.

2d. Two-foot box.

3d. Wood; span, 10 feet; height, 2 feet; condition good.

4th. Wood; span, 6 feet; height, 2 feet; condition good.

5th. Wood; span, 8 feet; height, 2 feet; condition good.

6th. Wood; span, 8 feet; height, 4 feet; condition good.

(16) 7th. Bowstring truss; steel span, 60 feet; height, 8 feet above water; pile abutments; 10-foot approach; condition good.

8th. Five plank; height, 2 feet; condition good.

9th. Wood; span, 10 feet; height, 3 feet; condition good.

10th. Wood; span, 6 feet; height, 8 feet; condition good.

(17) 11th. Steel truss; span, 65 feet; height, 30 feet; approaches of 40 feet and 25 feet; very good stone piers.

Rate of march. Time, 7 A. M., 10 A. M.; distance, 9.2 miles.

Villages. Kilmer; nothing more than a railroad siding; Atchison, Topeka and Santa Fe Railroad passes here (through trains.)

Streams. Indian Creek; 15 to 20 feet wide; clear water.

Soldier Creek; 30 feet wide, 4 to 5 feet deep; banks steep, muddy.

Country. Rolling farm lands; fields divided by hedge and barb wire fences; dome of capitol visible at A and B and frequently thereafter.

Camp grounds. Camp grounds could be gotten along either of the streams mentioned above.

Railroads. None along route.

Telegraph lines. Two wires; place for eight more; part of the road had four wires; usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 7.

Reform Farm to Silver Lake, Kansas, September 14, 1902.

The roadway. Road, 60 feet wide, practically level, low, and straight; difficult or impossible of drainage; wire and hedge fences; swampy places; considerable sand in road, thought to be bad in wet weather, but an inhabitant of Silver Lake stated that he had hauled two-ton loads to Topeka with three horses in all kinds of weather.

Bridges. No bridges.

Rate of march. Time, 7.30 A. M., 11.30 A. M.; distance, 11.68 miles.

Villages. Silver Lake; population, 250; blacksmith shop, post-office; telegraph and telephone lines to all points; about six stone buildings here; a main line of the Union Pacific Railroad passes through.

Streams. No streams, but Silver Lake is a considerable body of water.

Country. Generally level, soil sandy; view of two or three miles either side of road; dome of capitol and Washburne College in view to south of road.

Camp grounds. Would generally be chosen near the river which averages three-quarters of a mile from "the lower road." (See map.)

Railroads. A main line of the Union Pacific Railroad is near the road the entire distance.

Telegraph lines. Twelve wires with usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 8.

Silver Lake to St. Mary's, Kansas, September 15, 1902.

The roadway. Dirt road, 40 feet wide; fences, hedge and barbed wire; this road averages about 8 feet below the adjacent railroad track, and drainage is difficult or impossible.

Bridges. The following bridges:

1st and 2d. Wood; span, 10 feet; 8-foot stone abutments; condition good.

(18). 3d. Steel truss bridge; span, 70 feet; height, 25 feet: stone abutments; condition good.

4th. Wood box; 4 x 4 feet; condition good.

5th. Wood; span, 8 feet; height, 4 feet; condition good.

6th. Wood; span, 8 feet; height, 3 feet; condition good.

7th. Wood; span, 6 feet; height, 3 feet; condition good.

(19) 8th. Stone; span, 20 feet; height, 8 feet; condition good.

(20) 9th. Queen post truss; span, 14 feet; height, 8 feet; stone abutments.

Rate of march. Time, 6.30 A. M., 1.20 P. M.; distance, 14.74 miles; halt of one and one-third hours for lunch.

Villages and cities. Kingsville, about 30 population; stock yards and railroad station; 2.6 miles from Silver Lake on main road.

Rossville, population, 600; blacksmith shop, livery

stable, stock yards, stores of all kinds, and bank; telegraph and telephone to all points.

St. Mary's, city of 1,500; site of St. Mary's College, boys' school, Catholic, registers 300 students in addition; principal street has many stone buildings on either side; site of camp overlooks the whole city; difficult of defense; Union Pacific Railroad depot.

Streams. 1. Cross Creek, at Rossvile, 25 feet wide, with steep banks, possibly very deep in wet weather.

2. Burbony Creek.

3. Creek under bridge No. (20), 8 to 10 feet wide, near St. Mary's.

Country. Rolling farm lands; for three miles before getting to St. Mary's hills to the north control the road; open country to the left.

Camp grounds. The site at St Mary's was well chosen on a hill overlooking the city; water was gotten from wells at the bottom of the hill.

Railroads. Union Pacific Railroad runs parallel to road. (See map.)

Telegraph lines. Twelve wires on road and twelve on railroad; usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT No. 9.

St. Mary's to Waumega, Kansas, September 16, 1902.

The roadway. Dirt road, generally 30, 40, and 60 feet wide, and in fair condition; no unusual grades or very bad places; all grades given on map; last four miles of road a road scraper had been used recently.

Bridges. Bridges:

1st. Stone culvert; 8 feet long, 4 feet high; condition good.

(21) 2d. Steel truss; span, 30 feet; height, 10 feet; condition good.

3d. Wood; span, 6 feet; height, 4 feet; stone abutments; condition good.

4th. Seven plank; height, 4 feet; width of this bridge about 50 feet.

(22) 5th. Steel truss; span, 20 feet; height, 10 feet; approach, 10 feet; stone abutments; condition good.

(23) 6th, Steel truss; span, 20 feet; height, 20 feet; approach, 10 feet; stone abutments; condition good.

(24) 7th. Stone culvert 20 feet long, 8 feet high; stone abutments; condition good.

(25) 8th. Steel truss; span, 30 feet; height, 15 feet; stone abutments; condition good.

(26) 9th. Steel truss; span, 120 feet; height, 30 feet; approaches, 35 feet on either side; pile abutments; condition good; bridge in need of repairs; railroad bridge within 100 feet and strong; both have stone piers and abutments.

10th. Wood; span, 10 feet; height, 8 feet; near camp; condition good.

Rate of march. Time, 6.40 A. M., 1.35 P. M.; one and one-third hour halt for lunch; distance, 15.65 miles.

Villages. Belvue; population about 200; post-office, telegraph and telephone offices.

Waumega; population about 1,900; apparently flourishing little town on the Union Pacific Railroad; several stone stores and dwellings.

Streams. 1. Fitzgerald Creek, 8 feet wide; banks wooded and steep.

2. Riley Creek, clear water.

3. Terrain Creek.

4. Deep Creek, 20 feet wide now; banks very steep.

5. Lost Creek, small stream of clear water.

6. Vermilion River, about 65 feet wide; muddy and very steep banks; banks wooded.

Country. Rolling farm lands intersected with barb wire and hedge fences.

Camp grounds. Can be gotten near any of the above mentioned streams. That at Waumega excellent for small command, say, one or two regiments. City water can be gotten.

Railroads. The Union Pacific Railroad is in touch all along the route.

Telegraph lines. Some places ten wires; about four wires the entire

distance; usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 10.

Waumega to Elbow Creek, Kansas, September 17, 1902.

The roadway.

Road narrow, crooked, and hilly for about two miles after leaving Waumega; about one mile through woods, road good then till within about two miles from St. George. Here sand was struck and hills. In some places roadway was very narrow, due to washouts. Sand continued for about two miles beyond St. George. These four miles were by far the worst road of all for marching over or hauling heavy loads over in dry weather. At A the road is low and surrounding country swampy. Water covered the road for a distance of 75 feet to a depth of 12 inches. The dismounted men took the railroad track.

Bridges.

Bridges:

1st. Culvert 30 feet, 20 feet high; dry creek.

2d. Wood; span, 18 feet; height, 10 feet; condition fair.

(26) 3d. Wood; span, 10 feet; height, 4 feet.

(27) 4th. Wood; span, 20 feet; height, 8 feet; stone abutments; condition good.

5th. Wood; span, 8 feet; height, 4 feet; clear water; condition good.

The bridge across the Kansas River is a steel one of six bays resting on brick piers; condition good.

(28) 6th. Steel truss; span, 40 feet; height, 15 feet.

7th. Wood truss bridge; span, 20 feet; height, 4 feet.;

(29) stone abutments. Probably too weak for siege guns but can be flanked without great difficulty.

8th. Wood; span, 6 feet; height, 6 feet; stone abutments; condition good.

9th. Wood; span, 10 feet; height, 6 feet; condition good.

10th. Wood; span, 6 feet; height, 2 feet; condition good.

11th. Wood; span, 10 feet; height, 6 feet; condition good.

12th. Wood; span, 7 feet; height, 2 feet; condition good.

13th. Wood; span, 6 feet; height, 2 feet; condition good.

14th. Wood; span, 8 feet; height, 2 feet; condition good.

(30) 15th. Steel truss bridge: span, 40 feet; strong stone abutments; height, 30 feet; condition good.

16th. Wood; span, 10 feet; height, 10 feet; stone abutments; condition good.

17th. Wood; span, 6 feet; height, 2 feet; condition good.

Rate of March. Time, 6.30 A. M., 1 P. M.; one and one-third hours halt for lunch; distance, 14 miles.

Villages. St. George, population, 200; wagon works, Union Pacific Railroad station, stone buildings.

Streams. 1. Woody Creek.

2. Black Jack Creek, about 8 feet wide and 2 or 3 inches deep; water very clear.

3. Elbow Creek, width, 10 feet; 1 to 2 feet deep; banks very steep.

Country. Hilly and woods only along streams. At C is a line of hills commanding the road for several miles. At B the road climbs along a side hill.

Camp grounds. The camp ground at Elbow Creek was in a field and plenty of water was at hand. Here was ample room for a brigade encampment.

Railroads. The Union Pacific Railroad is followed, crossed, and recrossed.

Telegraph lines. None to St. George (error in map), after that four to Elbow Creek; usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 11.

Elbow Creek to Eureka Lake, Kansas, September 18, 1902.

The roadway. Country road of 30 and 40 feet widths. Generally in good condition in dry weather, but probably bad in wet weather. Defile and hilly road at A, after that swampy road, especially so at B, where water covered

road to depth of 18 inches and dismounted men passed via the railroad.

Bridges.

1st. Bridge of three 120-foot spans, bow-string trusses, (31) steel, and 100-foot trestle approach, wood; height, 35 feet above water; good stone piers and abutments.

(32) 2d. 200 feet south railroad bridge of two steel truss, spans of 150 feet each and 150-foot trestle approach; excellent stone piers and abutments; new piers 300 yards below for a bridge.

(33) 3d. Bridge, 75-foot span, steel truss; height, 25 feet; approach, 25 feet; good stone abutments; 200 feet south of railroad bridge of similar construction but stronger.

4th. Wood; span, 8 feet; height, 8 feet; condition good.

Rate of march. Time, 7.30 A. M., 11.15 A. M.; distance, 10.96 miles.

Cities. Manhattan, population, 3,500; many stone buildings. Nearly all stone on both sides of principal street; good building stone at C and perhaps nearer.*

Eureka Lake, summer hotel.

Streams. 1. Big Blue River; width, 125 feet, probably twice as wide in wet weather.

2. Wild Cat Creek; width, 10 feet, and 1 or 2 feet deep. Gets probably 75 feet wide and 10 feet deep in wet weather.

3. Kansas River near at all times.

Country. Hilly and in many places covered with rocks in the neighborhood and west of Manhattan.

Camp grounds. Good camp grounds at D and at Eureka Lake for one or two regiments.

Railroads. Union Pacific Railroad close to road at all times.

Telegraph lines. Four wires to Manhattan; Manhattan, three or four to Eureka Lake, including an electric light wire; usual wood poles.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

REPORT NO. 12.

Eureka Lake to Fort Riley, Kansas, September 19, 1902.

Reconnoissance only to reservation limits.

The roadway. Country road in very good condition in dry weather, probably bad in wet weather; hills give fair drainage till

the reservation is reached, after that the roadway is low and quite level.

Bridges. 1st. Wood; king post truss, span, 15 feet; height, 7 (34) feet; stone abutments; fair condition.

2d. Wood; span, 4 feet; height, 4 feet; condition poor.

3d and 4th. Two-foot boxes; condition poor.

(35) 5th. Same as first, excepting height, 10 feet; condition good.

(36) 6th. Wood; king post truss, height, 4 feet; floor poor; stone abutments.

7th. Wood; span, 12 feet; height, 8 feet; condition good.

Rate of march. Time, 7 A. M., 10.45 A. M.; distance, 9.98 miles.

Villages. Ogden, population about 200; blacksmith shop and wagon works, post-office, Union Pacific Railroad station.

Streams. None of any importance.

Country. Rolling farm land intersected by barb wire and hedge fences.

Camp grounds. None suitable en route on account of scarcity of water in dry weather.

Railroads. The Union Pacific Railroad close at hand at all times after the first three miles.

Telegraph lines. Two wires with usual wood poles.

(Reservation limits.)

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

HEADQUARTERS, 1ST BATTALION OF ENGINEERS,
CAMP LUDLOW, FORT LEAVENWORTH, KANSAS,
SEPTEMBER 7, 1902.

GENERAL ORDERS NO. 75.

Extract.

* * * * * * *

6. Lieutenant N. E. Bower, Corps of Engineers, is detailed as topographical officer.

BY ORDER OF MAJOR LEACH:

H. BURGESS,
1st Lieut., Corps of Engineers,
Adjutant.

Report of the marches made by the mounted detachments of the 1st Battalion of Engineers on their return trip from Fort Riley to Fort Leavenworth, Kansas.

Marches were made as follows:

No.	October, 1902.	From—	To—	Distance—Miles.	Time.
1	10th	Fort Riley	Manhattan	15.61	11.05 A. M. to 4 P. M.
2	11th	Manhattan	Wamego	20.50	7.35 A. M. to 12.45 P. M.
3	12th	Wamego	St. Mary's	15.65	7.15 A. M. to 11.35 A. M.
4	13th	St. Mary's	Silver Lake	14.74	7.30 A. M. to 11.30 A. M.
5	14th	Silver Lake	Meriden	25.88	7.15 A. M. to 12 M.
6	15th	Meriden	Winchester	27.16	7.20 A. M. to 3.30 P. M.
7	16th	Winchester	Fort Leavenworth	23.85	7.20 A. M. to 1.30 P. M.

Total distance, 143.39 miles.

CAMPS.

At Wamego, St. Mary's, and Silver Lake the same camps were used as in going to Fort Riley.

At Manhattan a camp was chosen just northwest of the town. The location and condition of the camp ground was all that could be desired. Water for the animals had to be gotten in the town, the only objectionable feature.

At Meriden suitable ground was gotten on the line of march just east of the town within the racetrack. Here also water had to be gotten from the town. The ground lies low and the track forms a border preventing good drainage, hence this would not be used in wet weather or for any considerable period of time.

At Winchester an ideal grass plot was gotten on the eastern side of the town. Water for the animals was gotten from troughs in town and drinking water from nearby houses. This camp was much superior to the camp south of town previously occupied.

MARCHES.

The same routes were taken on the return trip with the following exceptions:

From Manhattan to Wamego the road south of the river was taken. This route is about three miles longer than the north road, but the hills and the sandy road on either side of St. George (spoken of in previous report) were avoided. The road bed is low and not well drained. During a rainy season it would doubtless be very muddy, while the sand on the north road would not be bad. It is practically a level road and in dry weather good time can be made on it. It might here be added that these roads dry out quickly and probably a week after continued rainy weather this road would be good.

Near Belvue the south road was taken, passing through Belvue instead of going around it on the north. This road was quite muddy and would be worse than the upper road in wet weather, while it is not appreciably shorter. (See maps.)

Kilmer was not passed through. Instead of turning east when at a point 1½ miles west of Kilmer the command continued north 2 miles, then turned east following the main telegraph line into Meriden. The distance is the same as through Kilmer. The good road from Kilmer to Meriden was sketched by one of the parties and will be involved in the map.

The post was approached from the south road and the engineers' barracks terminated the march.

DIARY.

The command consisted of the four mounted detachments, one escort wagon, the pack train, and the advance guard bridge train. The return trip was made in seven days, covering a total distance of 143.39 miles. The average rate of marching was 20.48 miles. The longest march was 27.16 miles, and the shortest march was 14.74 miles. The only rain encountered en route was light showers at St. Mary's after the command had gotten into camp.

N. E. BOWER,
2d Lieut., Corps of Engineers,
Topographical Officer.

1st Endorsement.

HDQRS. 1ST BATTALION OF ENGINEERS,
CAMP ROOT, FORT RILEY RESERVATION, KANSAS,
SEPTEMBER 25, 1902.

Respectfully forwarded to the Adjutant-General, Maneuver Division, report and itinerary inclosed herewith.

The maps submitted are originals. It has not been possible to reproduce them on account of the dark weather which has prevailed. It is desired to take up the work of reproduction as soon as weather permits, and with this object in view I request the return of these maps as soon as the Commanding General has examined them.

SMITH S. LEACH,
Major, Corps of Engineers,
Commanding 1st Battalion of Engineers.

559-1902.

2d Endorsement.

HDQRS. MANEUVER DIVISION,
CAMP ROOT, FORT RILEY RESERVATION, KANSAS,
SEPTEMBER 28, 1902.

Respectfully returned to the Commanding Officer, 1st Battalion of Engineers.

The Division Commander is much pleased with the maps herewith. It is hoped the work of reproduction be done at this camp. Three copies will be desired at headquarters of the division.

Lieutenant Bower's report and itinerary has been retained at these headquarters. If desired for temporary use by the Commanding Officer, 1st Battalion of Engineers, it will be returned to him.

BY COMMAND OF MAJOR GENERAL BATES:

E. J. McCLERNAND,
Major of Cavalry,
Adjutant General.

APPENDIX NO. 2.

HDQRS. 1ST BATTALION OF ENGINEERS,
CAMP ROOT, FORT RILEY RESERVATION, KANSAS,
SEPTEMBER 19, 1902.

THE ADJUTANT-GENERAL,
DIVISION OF MANEUVERS,

SIR: I have the honor to submit the following report of the march of the 1st Battalion of Engineers from Fort Leavenworth to Fort Riley, in compliance with General Orders No. 34, Department of the Missouri, c. s., and General Orders No. 38, Post of Fort Leavenworth.

The Battalion left Fort Leavenworth at 10 A. M., on the 8th instant, with 8 officers, 198 unmounted and 78 mounted men in ranks; a wagon train of 9 tool and baggage wagons, with 38 mules, 1 civilian, and 8 enlisted teamsters; a bridge train of 15 wagons, with 60 mules and 16 civilian teamsters, an acting wagon-master for both trains, and a pack train of 24 pack and 7 riding mules, with a civilian chief packer and 7 enlisted packers.

A contract surgeon and 5 men of the Hospital Corps were attached.

The order of march adopted was as follows:

1st. The mounted detachment of one company as advance guard and reconnoissance party. This was followed by a foot column composed of Companies A, B, and D. Next came the battalion and company wagons, accompanied by the mounted detachment of one company as a guard.

Then followed the bridge train, accompanied by Company C as a guard, then the pack train and finally the mounted detachment of one company as a rear and provost guard.

Camps were made on sites determined before the march was begun, and fuel and forage were supplied by local contractors. The sites selected were at Lowemont, Easton, Winchester, Osawkie, Kilmer, Topeka, Reform Farm, Silver Lake, St. Mary's, Wamego, Elbow Creek, and Eureka Lake.

The battalion was rationed at Fort Leavenworth for six days, except the meat component which was for three days. Fresh beef was supplied at Winchester, Kilmer, Topeka, St. Mary's, Wamego, and Manhattan. Six days' rations except fresh meat were drawn at Topeka.

At each camp the battalion was disposed in a rectangle, with one side occupied by the picket line of the mounted detachments.

The camp guard was composed of the picket line guard and one post on each of the other sides. Eight reliefs were mounted, giving each sentinel one tour of about 1½ hours. Each relief was in charge of a non-commissioned officer. On reaching the vicinity of camp the advance guard posted a mounted picket on each road. These pickets were relieved at 2-hour intervals by members of the same detachment until 6 P. M., when the camp guard was mounted, at which time a picket post of a non-commissioned officer and four men was posted on each road, and the mounted pickets withdrawn. An officer of the day was detailed for duty from 6 P. M. until reveille.

The medical stores supplied for the march were inadequate in variety and quantity. There was not more than enough foot powder for issue to a dozen men. There was no quinine, though it was entered on the list on the lid of the box. There were no liniments. The surgeon telegraphed for quinine and foot powder and these were supplied at Meriden.

The sick report was not large at any time. A corporal of Company D was kicked in the groin by a horse on the morning of the second day and was sent back by train to Fort Leavenworth. He was discharged from hospital on the third day after his arrival and asked permission to join the column. He was authorized to do so at his own expense and rejoined at Osawkie. A corporal of Company B fell over a tent cord at Silver Lake and broke his arm near the elbow. He was sent back by train. One private was missing on the 17th. He was last seen near the well from which water was procured at the dinner halt. He complained of cramps and went through the fence to an adjoining field. He was not missed when the start was made and was not reported absent until after retreat.

Immediately after reveille the next morning an officer was sent back with a wagon and a thorough search was made as far back as the place where the halt was made. No trace of the man was found.

The weather during the entire period of the march was very good and the roads in their best possible condition. The nights were very cold. At Kilmer there was a heavy frost and ice formed. But one day was warm enough to have any effect on the men.

The reconnoissance was done principally by mounted men. An aggregate of about 350 miles of roads were traversed and mapped. All probable alternative routes were explored and all intersecting roads were covered for a mile or more on each side of the main route.

The battalion arrived at the camp of the Division of Maneuvers at 11 A. M., to-day and went into camp. Its present strength is shown by the field report already submitted.

Very respectfully,

SMITH S. LEACH,
Major, Corps of Engineers,
Commanding 1st Battalion of Engineers.

526-1902

APPENDIX NO. 3.

HDQRS. 1ST BATTALION OF ENGINEERS,
CAMP ROOT, FORT RILEY RESERVATION, KANSAS,
SEPTEMBER 24, 1902.

THE ADJUTANT-GENERAL,
BLUE ARMY,

SIR: I have the honor to submit the following report of the operations of the 1st Battalion of Engineers during the outpost exercise of to-day.

The mounted detachments of Companies A and B, with a commissioned officer and a pack train of intrenching tools, were sent to report to the Commanding Officer, 28th Battery Field Artillery. The remainder of the battalion, 8 officers and 198 men, with 2 surgeons and 5 men of the Hospital Corps, and 3 company tool wagons, left camp at 8.33 A. M., and marched by the Milk Ranch road to the vicinity of Morris Hill, where the position to be taken was pointed out. It was a commanding knoll between the branches of Forsyth Cañon.

On reconnoitering the position the northern face was found to present four distinct spurs. One company was assigned to the spur on each flank and the largest company was posted near the head of the ravine between the two extreme spurs, with pickets on each. The smallest company was placed in reserve toward the right flank which seemed the most important,

and a short distance in rear of the position. It had complete natural cover. On account of ravines intersecting the rear of the position a greater depth of disposition was not practicable.

The reconnoissance of the position, showing the location of each support and picket is herewith.

The battalion was in position and had begun entrenching at 10.01 A. M.

At 1.10 P. M., a few of the enemy's cavalry scouts were seen in front of the right of the position at 800 or 900 yards distance. They were fired on at the range stated and were apparently put out of action.

Aside from this the day was without incident.

Very respectfully,

SMITH S. LEACH,
Major, Corps of Engineers,
Commanding 1st Battalion of Engineers.

553-1902.

APPENDIX NO. 4.

HDQRS. 1ST BATTALION OF ENGINEERS,
CAMP ROOT, FORT RILEY RESERVATION, KANSAS,
SEPTEMBER 29, 1902.

LIEUTENANT-COLONEL WILLIAM STANTON,
11TH CAVALRY,
COMMANDING ADVANCE GUARD, BLUE FORCES.

SIR: (1) I have the honor to submit the following report of the participation of the 1st Battalion of Engineers in the reconnoissance in force made this day.

(2) The battalion left camp at 8 A. M., under orders to rendezvous at the Pump House Road, near the race track, at 8.45. The strength was as follows:

(3) Companies A, B, C, and D, less mounted detachments of A, B. and D, 6 officers, and 130 men.

Mounted detachments of Companies A, B, and D, 1 officer, and 50 men.

One company wagon with litter and tools. Regimental Field Hospital.

(4) The command reached its position in column on the Pump House Road at 8.30 A. M. Company C, Lieutenant Burgess commanding, was sent forward as support of the advance guard.

Verbal orders were received here from Colonel Rodney to march the command in column on a trail to be pointed out by Lieutenant Canfield, A. C., and not to deploy until ordered to do so.

At 9.15 the battalion, forming the reserve of advance guard, moved out as indicated. The march was continued from the cañon under cover of

Morris Hill until nearly at the junction of Estes and Milk Ranch roads, when orders were received to deploy on a rise west of Morris Hill, right resting on the high ground about 900 yards west, facing north, with the 6th Infantry on our left. This position was taken at 10 A. M., and held until after 11. About 10.30 orders were received to send a mounted detachment to Morris Hill to support a battery. These men were withdrawn from the firing line, and sent as directed.

Orders were received to change front to the right and come up on left in support of the 28th Battery.

This position was held for a few minutes when orders were received to leave a small support for the 28th and to advance to a ridge in front of on the right of another battery, number not known. In this position the action terminated. The part of the battalion with me did not fire during the day.

(5) The wagon containing the hospital stuck at the entrance of the cañon and returned to camp. The surgeons went forward with first-aid equipment and were directed to the right flank by the medical officer of the day. The battalion was left without any medical attendance.

Very respectfully,

SMITH S. LEACH,
Major, Corps of Engineers,
Commanding 1st Battalion of Engineers.

579-1902.

APPENDIX NO. 5.

HDQRS. 1ST BATTALION OF ENGINEERS,
CAMP ROOT, FORT RILEY RESERVATION, KANSAS,
SEPTEMBER 28, 1902.

LIEUTENANT-COLONEL WILLIAM STANTON,
11TH CAVALRY,
COMMANDING ADVANCE GUARD, BLUE FORCES.
(*Through Commanding Officer of the Support.*)

SIR: I have the honor to make the following report of the operations of Company C, 1st Battalion of Engineers, during to-day's reconnoissance.

Company arrived at the Pump House between 8.35 and 8.40 A. M. I reported to Captain Donaldson, Commander of the Support, for orders, and was directed by him to march my company in rear of the 19th Battery, F. A., and to act as a support for that battery. During the march to Morris Hill I followed this battery as directed.

When this battery came into position on Morris Hill, I was directed to report to Captain March for orders by Captain A. L. Lott, 6th Cavalry, acting as aide to the commander of the support. Having reported to

Captain March I was directed by him to place my company on the left of his battery as a support. In accordance with this order the company was posted in line of skirmishers on the military crest to the left of the battery, the left of the company being slightly refused so as to bring fire to bear against a flank attack.

When the battery was limbered up to move forward from Morris Hill the company was assembled and put into column of march following the battery. But at this juncture Lieutenant Canfield, acting as aide to Colonel Rodney, directed that I should remain on Morris Hill and act as support to the 28th Battery, which was advancing to this position. This order was obeyed. It was impracticable at this time to communicate the substance of this order to my immediate commander, Captain March, but this was done at the first opportunity.

After the 19th Battery had come into action on the hill to the east of Morris Hill, I received an order from Captain March (by orderly) to bring by company up on the left of his battery. I reported this order to Colonel Rodney, and was directed by him to comply with the same.

I immediately moved forward the company in double time on the line of and to the left of the 19th Battery, breaking the company into line of skirmishers before reaching the crest of the hill. Upon the appearance of my company on the crest of the hill, a few of the Brown Cavalry scouts, who had been observing the battery position from a point to the left front about 800 yards from the battery, fell back to the next ridge, out of range.

Upon direction of Captain March the company was advanced to the left front of the battery, so as to command the valley running at right angles to our front.

A small knoll about 200 yards to the left of my line entirely obscured my view toward the north. For this reason I posted a picket on the crest of this hill. This picket about 11.15 reported the advance of a Brown Cavalry patrol. I took one section of the company and gained the crest of the knoll at the double time, just as the cavalry patrol of about 12 men reached the crest of a ridge about 600 or 700 yards distant. Two volleys were fired, kneeling, at 600 yards, at this patrol, whereupon it retreated. I left this section posted on the knoll, then returned to the company. I had hardly returned when the Brown Infantry, in skirmish line, appeared on ridge about 1,000 yards away. Sights were set for 800 yards and when the enemy had advanced to this distance six volleys were fired before he had moved forward a hundred yards. A much heavier fire could have been delivered had ammunition been plentiful. When these volleys were delivered the Brown line was silhouetted against the sky, while my

line was screened by the grass at the edge of the trail in which the company was posted. For this reason it seemed apparent that the enemy must have suffered heavily from this fire. At this stage cease firing was sounded, but the Brown force on the left (right of his line) advanced about 200 yards, firing as they advanced. No reply was made.

Meanwhile the cavalry patrol appeared again on the left, and was driven back by five volleys from the detached section at 600 to 700 yards range.

This ended the operations of the company, as it was marched off when recall was sounded.

Very respectfully,

HARRY BURGESS,
1st Lieut., Corps of Engineers,
Adjutant, 1st Battalion of Engineers,
Commanding Company C.

575-1902.

APPENDIX NO. 6.

CAMP ROOT, KANSAS,
OCTOBER 7, 1902.

THE ADJUTANT-GENERAL,
MANEUVER DIVISION.

SIR: I have the honor to submit a report of the action yesterday in accordance with Problem No. 10.

The problem was to occupy and hold a defensive position to prevent a strong Brown force of all arms from reaching Fort Riley. The force under my command consisted of the 1st Battalion of Engineers, less one company; 6th Regiment of Infantry; A Troop, 8th Cavalry; 6th and 28th Batteries, Field Artillery.

The field hospitals of the Engineers and Infantry were with their respective organizations. Captain Wilson, Medical Department, reported as Chief Surgeon, and Captain E. B. Ives, Signal Corps, as Chief Signal Officer. Captain Ives furnished men and means of prompt and efficient communication with all parts of the position.

The line of defense selected rested its right on One Mile Creek, ran along the ridge upon which the reservoir and Ogden Monument stand, and continued in prolongation of this ridge across the gorge of Republican Flat, resting its left on Republican River. The disposition of forces made is shown in the order issued, a copy of which is herewith. All details of disposition were left to the subordinate commanders and officers named in the order. I rode over the right and center positions just before the action began and found everything in satisfactory shape. I did not find it necessary to make the slightest change.

The troops were in position a few minutes after 7 A. M., and shortly after 9, men and guns were well intrenched.

The instructions for fire regulation are given in the order and were carefully followed by the subordinate commanders, except that the two guns on the right replied to artillery fire from Morris Hill, which was not contemplated in the order.

The action on the right was opened at 10 A. M., by a battery of artillery from Morris Hill. This battery displayed a red flag from which it would appear that it had an artillery target. No guns of the defense had as yet opened and Brown scouts had been within 150 yards of the right artillery position without suspecting its presence. The infantry attack was developed a few minutes later, large bodies advancing in close order and infantry marching by the flank in plain view of the Blue lines. The only alternative suppositions are that the Brown did not suspect the proximity of the Blues or entertained a supreme contempt for their prowess. I adopt the former. This attack beginning on the right was developed to our left until it enveloped right and center with a thin and much exposed line.

At 11.15 A. M., I received information that the two guns on the right were out of action. I at once ordered two guns of the 28th from the center to replace these and also ordered two guns of the 6th to the right, intending to use them in case the mountain guns were late in arriving. The two guns of the 6th were in position ready to open when cease firing was first sounded, and the two mountain guns were unpacked, on their wheels, and ready to be run into the pits, when the action ceased on the right.

In the center the foot troops fired frequently at excellent targets at mid ranges. The four mountain guns on the left of the center were kept busy firing at excellent targets at close artillery ranges. The commander of this battery allowed a skirmish line of dismounted cavalry to march past the Pump House, to avoid a premature disclosure of his position, knowing that they were walking into a trap.

The work on the left was not under my observation, as I could not get to that part of the line during the action. The reports of subordinate commanders show that it was extremely interesting. Everything which appeared on that front was ruled out of action except one man of a cavalry troop whom the umpire, after a special intercession, allowed to go back with news.

The means of communication between the several parts of the position were left entirely to the Chief Signal Officer, Captain Ives. The dispositions were explained to him and he was left to make such arrangements

as he saw fit. He saw fit to make them most complete and effective, including a telegraph station on Morris Hill, which was in operation during the entire action.

The work of the cavalry patrol was most satisfactory. Prompt and clear reports were sent back almost from the time the troops left the position. On one occasion I was completely encircled by couriers, each waiting to hand me a report. At no time was I in the least doubt as to the enemy's disposition and movements.

When the action was suspended, in addition to the guns heretofore alluded to, there were two companies of infantry and a troop of dismounted cavalry in reserve which had not been under fire.

I invite particular attention to reports of subordinate commanders attached hereto. They present many details without which the progress of the fight can not be fully understood, but which I am not able to incorporate in this report.

The profile adopted for infantry trenches is that usually known as "kneeling trench." The trench is four feet wide on top, three feet on the bottom, and one-and-a-half feet deep. The parapet is one-and-a-half feet high and two-and-a-half feet thick on top. Men in this trench are secure from shrapnel fire and if lying on the bottom are also safe from shell, which must pass through six to ten feet of solid earth to reach them.

The conduct of all the troops under my command deserves the highest commendation. The reservation of fire was especially commendable. The zeal and enthusiasm of the officers and the interest and attention of the men would not be greatly exceeded in actual battle.

Very respectfully,

SMITH S. LEACH,
Major, Corps of Engineers,
Commanding Blue Forces.

591-1902.

APPENDIX NO. 7.

FORT LEAVENWORTH, KANSAS,
OCTOBER 27, 1902.

THE ADJUTANT,
1ST BATTALION OF ENGINEERS.
(Through Commanding Officer, Company A.)

SIR: I have the honor to submit herewith my report of the work done by Company A, 1st Battalion of Engineers, at the Fort Riley maneuvers.

Very respectfully,

H. W. STICKLE,
1st Lieut., Corps of Engineers.

FORT LEAVENWORTH, KANSAS,
OCTOBER 22, 1902.

THE ADJUTANT,
1ST BATTALION OF ENGINEERS.
(Through Commanding Officer, Company A.)

SIR: In compliance with Circular No. 7, Headquarters 1st Battalion of Engineers, Fort Leavenworth, Kansas, October 18, 1902, I have the honor to report as follows concerning the work done by Company A at the Fort Riley maneuvers.

Corporal Charles Lowenheimer and 1st Class Private Alvah H. Mitchell were on special duty as assistants to the maneuver division topographical officer from September 22 to September 26.

2d Class Private John Howry was on special duty as draughtsman September 23 to October 8.

Hydrographic survey of Kansas River. Five cross sections about 300 feet apart were sounded every 10 feet. The resulting notes have been plotted and the plot and a report upon this work have been submitted.

A copy of the above-mentioned report accompanies this report as Appendix A.

On September 23, the mounted section took part in a drill of the mounted company, pack train and bridge train combined.

On September 24, the company, except the mounted detachment, took part with the battalion on outpost duty as a part of the Blue Force, the company as battalion reserve. The company, by direction of the Adjutant, took up a position in close order in a sheltered position and accessible to the different parts of the line of the battalion supports and remained there until the close of the exercise.

The mounted detachment of the company with pack train was directed to report to Captain Charles T. Mencher, Field Artillery, at his camp.

It accompanied him to Sheridans Bluffs, where the work of intrenching the battery was given it. The mounted detachment of Company B was united with that of Company A on this day, all under command of Lieutenant N. E. Bower, Corps of Engineers. The non-commissioned officers laid out the gun pits and took immediate supervision over the work of digging them. The privates started the work of digging and later alternated with the enlisted men of the 28th Battery in digging. These pits were completed in about an hour and a half. Lieutenant Bower then reported to Captain Mencher for further instructions. He was referred to Colonel Miller, 22d Infantry, who was commanding the right of the line, who said he had no intrenching to be done and directed Lieutenant Bower to join the sup-

ports acting as infantry. As the principal attack was made on the left of the line, no active part was taken by any of the troops on the right.

The pit constructed was the German gun pit, the width of the gun portion reduced to 10 feet and not dug.

On September 26, I was directed to report with one platoon to the commanding officer of the 6th Infantry, to take part in an advance guard exercise. The platoon was accompanied by one escort wagon, carrying tools for intrenching and for bridge construction. These tools were not called for during the day. A copy of the report submitted to 1st Lieutenant James B. Kemper, 6th U. S. Infantry, acting as adjutant of the column, accompanies this report as Appendix B.

Lieutenant N. E. Bower, commanding the other platoon, reported to Lieutenant-Colonel Adams, 18th Infantry. The assembly was made at the hay sheds, at which place Lieutenant Bower reported to Colonel Adams, 18th Infantry.

One section of the mounted detachment with pack train was assigned to the support of the advance guard, one section with wagon to the reserve. After the advance guard had moved forward some distance, the enemy was encountered and very soon the support was put on the firing line. In the absence of orders Lieutenant Bower turned over the horses to the horse holders, and they with the pack train were left in a protected place while the rest of the detachment was taken to the right of the firing line and advanced with the firing line, now almost a mile long, in the direction of Morris Hill. Before reaching this place the engagement terminated. The second section, under Corporal Jacoby, was not engaged. After lunch at Morris Hill the rear guard formation was taken up and the platoon was assigned to the reserve.

September 27. The company, except the mounted section, took part in the exercises of the day with the battalion under the direction of the Battalion Commander. When the battalion left the Governor Harvey Road to ascend the hills to the right, the company was left behind to assist in getting the bridge train up these hills. A muddy portion of the road was repaired by throwing in rock of which a large quantity was available in the immediate vicinity. Each wagon was assisted up the first hill by a squad of men and no further difficulty was encountered for about a quarter of a mile, when the tool wagon upset. The wagon was righted and the contents piled therein and the train proceeded without further mishap.

The company joined the battalion about 12 M.

The mounted detachments of Companies A and B were united under

command of Lieutenant Knight, Lieutenant Bower being second in command. The two detachments with their pack trains were assigned to the reserve of the advance guard. The absence of orders was very conspicuous at this time for they were left totally in the dark as to their functions and they rode with hospital wagons in front of and behind them until quite near the firing line. Here they were dismounted to fight on foot and joined the firing line just as the engagement was ended.

September 30. The mounted section, 5 non-commissioned officers and 21 privates dismounted section in conjunction with a detail from Company D, completed in the forenoon the construction of the approach to the ponton bridge on the south bank of the Kansas River.

The first three days of October, 2 non-commissioned officers and 12 privates were on duty under the orders of Captain C. A. F. Flagler at the ponton bridge.

Drills were had on October 1 and 2 in the construction of low and high wire entanglements for such men of the company as were available.

October 6. The company took part with the battalion as a part of the Blue Force.

A copy of my report of operations on that date to the Adjutant-General, Blue Force, as engineer officer in charge of the intrenchment of the center of the line of defense is appended (see C.)

This report includes in a general way the operations of the company.

From the right of the five squad trenches of this company, Lieutenant Bower had command of the first and second squads, I had command of the third and fourth, and Lieutenant Frazier the fifth. No firing was done at a greater range than 600 yards, and the firing at individual scouts of the enemy and at small squads was individual, volleys being fired when the enemy appeared in sufficient force at the short ranges to justify it.

October 7. The company with the exception of the mounted detachment took part in the exercises of the day, with the battalion acting as a part of the Blue Forces.

From 10.15 to 11.30 A. M., the company acted with Company B as a support to the 20th Battery, Field Artillery.

These two companies then joined the Battalion Commander and Company A acted as battalion reserve, while the Blue line was forming, keeping 400 paces in rear of the battalion supports and on its left flank. The company was then put on the line at the extreme left of the Blue Force, with the exception of the Engineer Mounted Company, which position it held until the close of the exercise.

The three mounted detachments were united under command of Lieu-

tenant Pope, Lieutenants Knight and Bower commanding platoons. Later a detachment of about 12 men of the 8th Cavalry reported to Lieutenant Pope. Advance guard was formed with these mounted men in a deep ravine. Before it was entirely formed the flankers were engaged. Lieutenant Bower requested a patrol of Lieutenant Pope to round up stray parties of the enemy. This was given and he moved forward with the patrol on the enemy's left. The small parties anticipated proved to be the enemy's firing line. Lieutenant Bower being directly on the flank of this line dismounted his small patrol and enfiladed the line as it retreated. After moving back about 800 yards the firing line had developed considerable strength. Here three volleys from a battalion was drawn, besides obtaining good shots at the enemy's officers. Lieutenant Bower rode back and gave the information to the advancing line, meanwhile leaving the patrol under command of the sergeant in a secluded place. When he returned the patrol had been ruled out by an umpire. Lieutenant Bower then joined Lieutenant Knight, operating with his mounted detachment and part of A and B companies on the enemy's right. After getting on the rear of the right of the enemy's line an umpire notified Lieutenant Bower that the detachments were ruled out. This terminated the operations of himself and detachment for the day.

October 8 at 4 P. M., all available enlisted men of the company were reported to the Commanding Officer, Company C, for duty during the exhibition exercise of the dismantling and reconstruction of a portion of the ponton bridge.

To Company A, Engineers, was assigned the work of adding a 3-mile border to maps of the reservation already existing. Lieutenant Bower was directed to take entire charge of this work and it was pushed as rapidly as possible. Two unforseen circumstances materially delayed this work In the first place it was difficult to attach our road sketches to these maps as they had been compiled from information gotten from various sources and in many cases the roads were incorrect. Then again the weather was rainy, rendering the roads so muddy as to be almost impassable.

Permission was gotten from the Adjutant of the battalion to start from the interior of the post and work outwards. Both mounted and dismounted men were used for the work. In order to make the interior work more accurate the Water Tower, Morris Hill, and Sheridan's Bluffs were located by triangulation, using a paced base line, and bearings were taken from these to other points. The work was then carried on as far as time would permit. No effort was made to make a map of the

post proper, as good maps of this already existed. The result of the work was traced and blue prints have been submitted.

Very respectfully,

H. W. STICKLE,
1st Lieut., Corps of Engineers.

1st Endorsement.

FORT LEAVENWORTH, KANSAS,
OCTOBER 27, 1902.

Respectfully forwarded to the Adjutant, 1st Battalion of Engineers.

THOMAS H. REES,
Captain, Corps of Engineers,
Commanding Company A.

CAMP ROOT, FORT RILEY, KANSAS,
SEPTEMBER 26, 1902.

1ST LIEUTENANT JAMES B. KEMPER,
6TH UNITED STATES INFANTRY.

SIR: I have the honor to report the following operations of the first platoon, Company A, 1st Battalion of Engineers, this date.

Having been informed by the advance guard commander that the 6th Infantry would assemble at 8.30 in its camp, and pursuant to his instructions that the platoon would join that organization as it passed the camp of the 1st Battalion of Engineers, it was directed that the platoon fall in at 8.30 A. M., so as to be prepared to join at 8.40 A. M.

The 6th Infantry passed at 8.22 A. M., and I was directed by the Adjutant to join the 6th Infantry as soon as possible at the Pumping Station. The platoon left camp at 8.35 A. M., and was reported to the advance guard commander 9.10 A. M. I was directed to lead the reserve with the platoon. At about 11 A. M., the platoon was ordered on the firing line. It advanced about 800 yards in extended order to a line 15 yards in advance of the battery and on its left. It there opened fire on the Brown in extended order about 600 yards distant. After one volley, the order to cease firing was received.

On the return march, as a part of the rear guard in retreat, the platoon was assigned to the reserve and placed at its head, a position it held until the rear guard was attacked, which occurred after the platoon had entered the north end of the gully on the Governor Harvey Road north of its intersection with Milford Road. The Infantry and Artillery of the reserve were withdrawn. When firing began on our right and in our advance, I moved the platoon to an advantageous position near the south extremity of the gully, with a view of resisting an attack from that direc-

tent. The platoon occupied the position until recall. The platoon commander then reported to the rear guard commander and was directed to return to the engineer camp with his platoon.

A sketch of the route of march and area of engagements was made by Corporal Philgren, Company A, 1st Battalion of Engineers, and he was directed to submit the same to the Commanding Officer of the column.

Very respectfully,

H. W. STICKLE,
1st Lieut., Corps of Engineers,
Commanding First Platoon, Company A, 1st Battalion of Engineers.

CAMP ROOT, FORT RILEY RESERVATION, KANSAS,
OCTOBER 6, 1902.

THE ADJUTANT-GENERAL BLUE FORCES:
CAMP ROOT, FORT RILEY, KANSAS.

SIR: I have the honor to report the following entrenchment of the center of the line of defense this date, under my direction.

The general plan adopted was the standing trench and such further thickening of parapet, without deepening trench, as time would permit.

The trenches were for squads, proper provision being made for containing such file closers as might be assigned to squads, ranks being generally refused. The center occupied four ridges, separated by ravines, opening to the west over Pump House Cañon on a general north and south line from Milk Ranch Road to Ogden Monument.

1st ridge. Five squad trenches in echelon, occupied by Company A, 1st Battalion of Engineers, 52 strong.

2d ridge. Two squad trenches occupied by one platoon, 1st Battalion of 6th Infantry, 14 strong.

3d ridge. Three squad trenches occupied by one company, 1st Battalion of 6th Infantry, 30 strong.

4th ridge. Four gun-pits, occupied by guns of the 29th Battery (Mountain). On the south slope of this ridge was entrenched the artillery support. This ridge was entrenched under the immediate supervision of Lieutenant N. E. Bower, Corps of Engineers. Lieutenant Bower, the mounted detachment, and all non-commissioned officers of the company engaged in supervising intrenchments for the infantry joined the company at 10 A. M., and took their places in the trenches.

All the trenches made for foot troops were on soil closely underlaid with solid rock. A modification of the standing trench was therefore made, and with the exception of the second ridge, by a trench very similar to the regular kneeling trench, a thicker parapet being, however, pro-

erally obtained. On the second ridge directions were given and later directions for necessary modifications; these directions were misunderstood and a parapet, or rather a stone wall, was built mostly in elevation to a height of about four feet, thus affording a good target for the enemy.

This was not a key point, very weakly held, its occupancy not essential and though not intended, I am of the opinion that making this parapet prominent was a fortunate occurrence in that I noticed the enemy's fire constantly directed toward it, and to the advantage of that part of the line which was occupied in stronger force.

All trenches with the above exception were well concealed in with grass, cut and placed, and as long as Company A, Engineers, remained in their trenches, I am confident that the enemy had not located its trenches, and were ignorant of the fact that their lines were being fired upon by our men sheltered only 300 to 500 yards distant.

The final attack of the enemy was made against the position held by this company, and consisted of a line of skirmishers followed by other lines of supports and reserve. This entire force was under fire as above for about ten minutes. The company was then ordered forward from the trenches by Major Morton, 6th Infantry, to the military crest for the purpose of firing upon those of the enemy who had advanced toward us over the military crest of the hill in our front. The company was at once brought back to the trenches. Probably the enemy opposite to it were out of action before the company left its trenches and the company was under no other fire before it returned to the trenches.

A sketch of the positions occupied by the center and the location of the intrenchments accompanies this report.*

Very respectfully,

H. W. STICKLE,
1st Lieut., Corps of Engineers,
In charge of trench construction for the center of line of Blue Forces.

Enclosure.

HDQRS. COMPANY B,
1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANSAS, OCTOBER 23, 1902.

THE ADJUTANT, 1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANSAS.

SIR: In accordance with Circular No. 7, Headquarters 1st Battalion of Engineers, Fort Leavenworth, Kansas, October 18, 1902, I have the honor to make the following report:

* * * * * * *

* Not printed.

The work done by Company B at Fort Riley during the period of the maneuvers was as follows:

September 20, 1902—

Making camp.

September 21, 1902—

Sunday.

September 22, 1902—

Constructing a road and bridge across the gorge of One Mile Creek, leading from the main road northeastward to the Field Hospital.

September 23, 1902—

Same as September 22.

September 24, 1902—

Formed part of Blue outpost of an army corps. The support intrenched itself with tools carried in army escort wagon.

September 25, 1902—

Cutting timber for double-lock spar bridge, and worked on road begun on the 22d instant.

September 26, 1902—

Company assisted Company C in constructing ponton and trestle bridge and corduroying approach thereto.

September 27, 1902—

Participated with the Battalion of Engineers on Blue advance guard for a division of full strength.

September 28, 1902—

Sunday.

September 29, 1902—

Participated in problem of contact of forces of all arms.

September 30, 1902—

Collecting materials for spar bridge and loading ponton bridge material on wagons.

October 1, 1902—

Same as September 30.

October 2, 1902—

Same as October 1.

October 3, 1902—

No work.

October 4, 1902—

No work.

October 5, 1902—

Sunday.

October 6, 1902—

Formed part of Blue defensive line in problem of attack and defense of a position.

October 7, 1902—

As Blue infantry in tactical exercise for a division.

October 8, 1902—

Assisted in dismantling ponton bridge. Began construction of double-lock spar bridge over gully just east of Three Mile Creek.

October 9, 1902—

Completed spar bridge and dismantled it.

October 10, 1902—

Entrained for Fort Leavenworth and arrived there at 5.20 P. M.

* * * * * * *

With reference to the matter of equipment, I believe the maneuvers at Fort Riley demonstrated again the necessity for an infantry intrenching tool. In moving infantry in an open country or in holding a position suddenly attacked, it is absolutely necessary for infantry to intrench, and this can only be done satisfactorily with a tool carried on the person of the infantryman. It is not to be assumed that engineers with tool wagons or pack trains will be present with all forces of troops, and even if they were present the distribution and collection of tools before and after the intrenchments are made, present such practical difficulties that nothing but the tool carried on the person can be safely relied upon.

There is no difficulty in carrying tools in wagons to be used in positions which are to be fortified and held for a lengthy period. The same may be said of tools in pack trains, but as yet the Engineer Department has not devised or adopted a pack train outfit, nor has the question of the kinds, sizes, and quantities of the various tools to be carried in wagons or pack trains been decided. The experience gained by the battalion at Fort Riley in that direction was so meagre, in my opinion, that it is of little value in determining these questions. I would recommend immediate purchase of an English pack train outfit for experimental purposes.

The equipment of the engineer soldier is satisfactory, except that the carbine should have a strap-sling and a stacking-swivel, so that it may be carried over the shoulder, thus leaving both hands free as well as making the piece easier to carry on the march, and so that the pieces can be placed in an orderly arrangement on the ground when not in use.

The road and bridge work executed by Company B was of such a nature that no new points were brought out with reference to the Engineer equipment. Where extensive and rapid road work is to be accom-

plished, use may be made of modern inventions for road work, obtained from the nearest commercial supplies, rather than in attempting to carry such articles with the army in the field, whose main reliance will always be upon the pick and shovel alone.

Very respectfully,

GEORGE A. ZINN,
Captain, Corps of Engineers,
Commanding Company B.

COMPANY C, 1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANSAS,
OCTOBER 28, 1902.

THE ADJUTANT, 1ST BATTALION OF ENGINEERS,
PRESENT.

SIR: I have the honor to submit the following report of the work performed by Company C of the battalion during the recent maneuvers at Fort Riley, Kansas, and the journey to and from the maneuvers.

The advance guard ponton train was assigned to Company C by the Battalion Commander prior to the march to Fort Riley. The train consisted of eight ponton wagons, one tool wagon, two chess wagons, and two trestle wagons fully equipped (the forge wagon was shipped by rail). These wagons had been modified for hauling by the removal of the splinter bars and the substitution of double and single trees for four mules. Brakes were also attached to the rear wheels of all except the tool wagon, for use on gentle grades where locking the wheels would be inadvisable; these brakes were operated by the teamster from his saddle on the near wheeler by a line attached to a brake lever of ordinary form. The harness used was that known as jerk line harness. The teamsters were all civilians.

The wagons stood the march to Fort Riley fairly well; the brakes proved difficult of operation from the saddle and were generally operated by a man riding on the wagon for the purpose. I am convinced that the double tree attachment is much better for the purpose than the splinter bar. The jerk line harness is, however, objectionable, it being very difficult to prevent the mules, on turning to the left, from turning too short. I should recommend the adoption of four line harness, with the teamster riding on the wagon; this would also facilitate his working the brake.

Several front bolsters on the wagons broke and one wheel, due to dry rot in the wood; one locking-chain also broke.

The country crossed was not difficult; the weather was fair with little mud. From Leavenworth to Topeka rolling country, with fairly steep

hills; from Topeka west, generally level roads with some heavy sand.

The company, which was formed almost entirely of recruits assigned in June, 1902, had had little practice in ponton work, only the month of August being devoted thereto. Exercises were had during that month in knots and lashings, in boat and flotilla drill, construction of ponton bridge with reserve equipage, construction of trestle bridge on land and water, and assembling of advance guard pontons on land. The assignment to to the advance guard train occurred too late for any practice with it upon the water.

The composition of the company when it left Fort Leavenworth was as follows: One captain, six sergeants, eight corporals, two cooks, one acting musician, twenty-nine first-class privates, twenty-three second-class privates. The captain, one corporal, the acting musician, and four privates were mounted. One 2d lieutenant joined the company October 1 and one corporal and one private were sent to Fort Leavenworth sick. The average daily sick during the march and maneuvers was 1.4 in quarters, 1.0 in hospital; on the march the average was .66 in quarters, and none in hospital.

On the march the company was formed on the train as follows: The men in heavy marching order were assigned by squads to certain wagons, deposited their blanket rolls upon the wagons and marched beside them on each side in column of files carrying their carbines and other equipments. They gave assistance in locking wheels, handling brakes, and correcting position of loads when necessary. Each squad remained under charge of its corporal who was responsible for its discipline on the march. The sergeants were distributed along the train and exercised general supervision. A mounted corporal carrying the company guidon rode abreast of the leading wagon. The company commander rode at the rear of the train followed by the musician and the remainder of the mounted detachment acting as orderlies.

The rate of moving of the column as determined by the record of September 10, taking into account all stops, was as follows: 3.11 miles per hour, actual marching rate. With the ordinary ten-minute halt every hour this would become 2.49 miles per hour. The remaining companies of the battalion marched just in front of the train and numerous extra stops were made on account of this slower rate of march. The actual rate on September 10, including all these stops, was only 2.1 miles per hour. This continual halting was rather wearing upon the men and mules, but was largely corrected by the orders of the Battalion Commander for the wagon train to leave camp each morning twenty minutes

after the foot column. On September 11 these rates were 3.47 actual marching rate, 2.97 with ordinary stops, 2.24 including all stops; one, a dinner halt of one hour and twenty-eight minutes.

Several small bridges over road drains broke under the train during the march but nothing of any consequence. On two occasions a few chess were used to floor over breaks but nothing more was necessary.

The command arrived at Fort Riley on September 19 and encamped about a quarter of a mile to the northeast of the artillery post. The journal of operations at Fort Riley is as follows:

September 19 and 20. Setting up and ditching camp, digging sinks, etc.

September 21—Sunday. Made inspection of river with a view to throwing ponton bridge across. General Bates having expressed a desire to have bridge debouche about the middle of the Smoky Hill Flats, south of the Kansas River, I selected a site opposite the dumping ground south of the railroad station (shown on map herewith).* This was the only point opposite the flats that possessed a road leading through the woods and obviated any further search. The sand bar shown on map was about three feet above water, and it was my design to utilize it to shorten the bridge so as to avoid the use of trestles. The Battalion Commander approved the site selected.

September 22. Launched three wooden pontons at lower ford, three-quarters of a mile below bridge site. One of these was taken up to site, other two turned over to Lieutenant Stickle for hydrographic survey of river.

Cleared brush from road leading to site, cut fifty yards new road around dump pile which was too soft for passage of animals.

Cut approach through north bank to level of sand bar, cut nineteen logs for corduroy. Tried to blast down approach on south shore; fired two blasts of one and three pounds of dynamite, respectively, with little effect, material being sandy loam; no blasting powder was available, so this method abandoned. Stopped at 4 P. M., owing to rain.

September 23. Drizzling rain in the morning; company engaged in equipping reserve train with anchors, cables, lashings, etc. In the afternoon weather cleared and company began work at bridge site, cutting approach on south bank and corduroying road on sand bar. Stopped work at 2 P. M., owing to heavy rain.

September 24. Company took part in maneuver representing attack on the outpost of a division, the Battalion of Engineers being a portion of the outpost. The battalion left camp at 8.30 A. M., marched to Morris Hill, and then east along ridge running to Sheridan Heights. Company C

* Not printed.

was assigned to center of battalion line and its position indicated by the Battalion Commander along this ridge. I selected a position on military crest of ridge for the company in support and sent out four cossack posts on points of ground projecting into the ravine in the north and connecting with the posts of Company D on my left, company tool wagon delivered tools and intrenching began (theoretically only) at 10.21 A. M., dug kneeling trenches to 11.20, then lying trenches about fifty yards on either flank in case line of resistance should be broken. About 11.30 discovered Company B had moved forward to a position on my right front and was overlapping my cossack posts. I shifted the posts to the left and front to make the line continuous and moved the company to a new position about 100 yards to the left front of its original one, as orders had been issued to remain concealed after 12 M., the men lay in the grass and further intrenching was not resorted to.

Heavy firing was heard to the left and some musketry to the right, but no enemy was seen. At 2.30 P. M., the cossack posts were relieved and at 3 P. M., recall was sounded and the command marched back to camp.

September 25. River had risen considerably, cutting through bar next to north bank. Built a log and brush dam and corduroyed with brush and logs 130 feet of road, 10 feet wide on bar. In the afternoon a further rise of 12 inches cut around the dam, and showed the use of the bar to be very precarious. Selected new line of crossing which was that finally used; sextant measurements showed it 470 feet between sills. The reserve ponton material contained only 17 pontons, so it was decided to use seven trestles, leaving one boat as a guard boat. Reported to the Battalion Commander that the operation required more than one company and he ordered details from other companies to assist on the following day.

September 26. Sergeant Hurtt, with Company C, hauled eight pontons to lower ford, launched them, and endeavored to row up the river but failed owing to heavy current and strong down stream wind. Half of Company B, under Sergeant Neid, cut road (shown on map) to new bridge head and corduroyed about half of it.

Company D began work on south approach with picks and shovels and about half completed it. Set a river gauge in old approach on north bank.

September 27. Sergeant Hurtt with twenty men (all available) unloaded remaining six pontons at south approach, launched them, and moored them on the north bank. In the afternoon hauled balk and chess to the bridge site. The poor appearance of many of the balk caused suspicion as to their strength, and the Battalion Commander ordered them

all tested before use. I began testing them in the afternoon, using the following rough method: Two abutment sills were laid upon the ground parallel and twenty feet between their inner edges. Each balk was laid across the sills, then six men each laid a chess at right angles to the balk, three on each side, their ends touching on the balk, other ends on the ground; each man then mounted his chess standing as close together as possible over the middle of the balk. The deflection caused by this weight was obtained by measurement before and after. Calculation showed proper deflection for entire load of 1,100 pounds (six men and three chess), on 20-foot span to be 3.02 inches. All balk showing four inches or more were rejected.

September 28—Sunday. The company brought all boats to the bridge site, eight from lower ford, two which had been used for survey from the Highway Bridge.

September 29. The company went out on maneuver under command of Lieutenant Burgess. With a detail of eight men I tested remaining balk.

September 30. Detail from Company D finished south approach.

Detail from Company B loaded material at depot; Company C constructed seven trestle bays from north approach. These bays were all rope-braced, as shown in sketch herewith.*

Seven balk were laid in each bay for greater strength, the additional balk being placed between the outer ones on each side. It was later shown that under the passage of horses the deflection of the middle balk causes greater jumping of the chess, frightening the animals Placing the additional balk adjacent to the middle balk would diminish this jumping and I should so arrange them in the future.

The footing to the trestles scoured out very rapidly, causing settlement amounting in cases to over two feet. To correct this the caps were raised with a block and fall.

Large masses of drift began running in the river, mostly small stuff, but containing occasional large trunks (largest measured two feet, seven inches in diameter). To protect against the shock of these a 75-pound anchor was dropped twenty yards upstream from each trestle and the cable drawn tight to the upstream leg leading through the slot in the upstream end of the cap; large logs brought up fairly gently on this cable instead of striking legs.

A guard of twelve men and one non-commissioned officer was put on the bridge in the afternoon and retained there until the bridge was finally removed. One sibley tent and stove were set up near north approach for use of guard. Orders for bridge guard are appended hereto.

* Not printed.

October 1. Company C, with detail of twelve privates and two non-commissioned officers from each of the other companies, began construction of the bridge at 8.45 A. M., completed 12 M.; sixteen bays with boats, making twenty-three bays in all; total length between sills, 448 feet.

The men were distributed as follows:

	Non-commissioned officers.	Privates.
Three upstream anchor detachments	3	12
Cable men	2	-------
Balk lashers	2	8
Balk carriers	1	14
Side-rail carriers	1	4
Side-rail lashers	-------	2
Chess carriers	1	22
Total	10	62
Superintending boats	1	-------
Keeping bridge free of drift	4	12

The need of pointed log-hooks was much felt in handling drift as hardly any holding could be secured with the boat hooks.

October 2. In spite of the efforts of the bridge guard who had worked almost the entire night, three large accumulations of drift were found on the bridge in the morning. Two anchors had been carried away by drift and a hole punched in one ponton above the water line. One balk was broken and two trestle legs. Sixth trestle was sunk by drift and scour so that roadway was partially under water. Dismantled three bays and cleared out the drift. Built trestle raft, reset fifth trestle and tried to reset sixth but had not sufficient long legs and short ones would not hold. Decided to use only five trestles and utilize the remaining two boats which had been intended for guard boats. Dismounted trestle raft, and rigged one boat as rope ferry for use of guard across opening.

October 3. Very cold and rainy, did not take company out; bridge guard worked from 8 to 10 clearing away drift from trestles. Lieutenant Ralston went to Junction City and hired a skiff for use as guard boat during passage of troops.

October 4. Rapidly rising river, endangering trestles. Took all of Company C, and one officer, two non-commissioned officers, and twelve privates from Companies A, B, and D, each. Dismantled trestle portion of bridge; the river was over the bank doing some damage to corduroyed road and compelling the men to work knee deep in water. Dismantled

south shore bay, to give easy motion to bridge on rise, and sent guard tent to south bank.

October 5—Sunday. No work.

October 6. Constructing trestles again, using five; river had fallen considerably. Completed bridge in the afternoon using all the boats (17) and shortening two bays. Moved guard back to north bank. Signal Corps put telephone in tent connecting with Battalion Headquarters.

October 7. In the morning repaired road where damaged by flood. Cut south approach to new water level.

In the afternoon received word that the infantry would cross bridge about 2 P. M. The infantry arrived at 3.30, crossed the bridge in column of twos and returned in the same formation followed by two squadrons of cavalry and two field batteries that had crossed to the south bank by the Highway Bridge. The Signal Corps automobile, weighing 2,500 pounds, with five passengers, also crossed and recrossed the bridge. The company was distributed two men in each boat to assist bridge guard in enforcing rules; those in the sterns of the boats were equipped with boat hooks and lines to assist any who might fall off the bridge. A member of the guard was in the guard skiff on lower side of bridge ready also to go to the assistance of anyone who might fall in the water.

No breaks of any kind occurred except one chess, which broke under the weight of a horse. It was plainly rotten and was promptly replaced with only one minute halt. The column was halted again for a minute and a half to replace a few chess that worked out from under the side rail on the midstream saddle bay.

After the crossing, three bays were dismantled and reconstructed as an exhibition.

October 8. Companies C, D, and A dismantled bridge in the morning and loaded three pontons on wagons. In the afternoon Companies A and D worked at the railroad depot loading material on train. Companies B and C at the bridge site. All the remaining pontons were loaded and all other material except seven wagon loads. The pontons were loaded by the method of excavating trenches for the wagon wheels about eighteen feet from the bank. The boats were brought stern first to the bank with a cable attached to the two stern posts and led out over the wagon. The bulk of the men heaved on this rope, a few guiding the boat and placing rack sticks for rollers. Sergeant Hurtt directed this loading, and after the first three boats the average time of loading, including unhitching and hitching mules, was six and one-third minutes, with balk already on wagon; eight and one-half minutes when balk had to be placed on wagons.

October 9. Finished loading at both bridge site and depot.

October 10. Returned to Fort Leavenworth by rail.

RECOMMENDATIONS.

The experience with both trains leads me to suggest the following:

1st. That all wagons be equipped with single and double trees and brakes, and that the teams be driven with lines from the wagons.

2d. That one of the boat hooks prescribed for each ponton be made sharp on hook and point similar to log hooks, for convenience in handling drift.

3d. That each ponton company be equipped with twelve oil skin coats and hats and twenty-four pairs of fishermen's rubber boots.

4th. That a suitable block and fall with slings be provided for use in raising and lowering trestle caps, without dismantling bridge.

5th. That the top of the trestle leg be modified in form to stand the continued blows of the maul without brooming and splintering. When the trestles are wet the legs show a tendency to jam in the caps and require a great deal of driving.

6th. To supply four false legs with each trestle.

7th. That each division of the reserve guard equipage should be supplied with a small boat for general work, soundings, life saving, etc. It should be of a size to be carried in one of the ponton boats. I should recommend a boat of dory build, 16 feet over all, 5 feet beam, 4 feet wide at stern, 3 feet 4 inches at bottom amidships, 3 feet at stern. Stem post cut under to prevent heavy shocks on striking drift. The flare on the sides gives additional stability to enable men in the water to crawl into the boat over the gunwales without swamping it. It should pull two pair of oars and have seat for steering oarlock on each side at stern; an iron-lined notch should be provided in middle of stern to lead an anchor cable through, and ringbolts bow and stern by which it may be slung. The boat should be flat bottomed, with small keel under the run aft. A heavy keelson should be used in construction to give longitudinal stiffness. Such a boat should weigh probably four hundred pounds.

Suggested method of carrying out recommendations 4 and 5 is shown on sketch herewith, No. 4.* A triple block is thought necessary to avoid unduly racking the trestle. The pull is necessarily parallel to axis of bridge and with the fall used at Fort Riley (one double and one single block), it was necessary to have twelve men to pull, and the racking was excessive. A spare trestle chain would form the best sling at bottom. The upper sling, suitable for present or suggested form of trestle leg, is shown

* Not printed.

on sketch. The block and fall is also found useful in raising anchors when firmly imbedded in bottom.

I desire to particularly commend the services rendered by the following men of the company during the maneuvers:

Sergeants Loper, Hurtt, Robbins, Lunny; Corporals Regan, McGrath; First-class privates Bolduc, Doyle, Layton, Leary, Stewart; Second-class private Fletcher.

Sergeant Crotty, of Company D, made a very good sketch of the site with the improved cavalry sketching case.

Sergeant Davignon, of Company A, did noticeably good work with a boat party during the construction and dismantling of the bridge.

Very respectfully, your obedient servant,

C. A. F. FLAGLER,
Captain, Corps of Engineers,
Commanding Company C.

RIVER RECORD.

Date.	Time.	Reading.	Date.	Time.	Reading.
September 20	----------	−1 foot, 6 inches.	September 30	1.30 P. M.	+5 feet, ½ inch.
September 21	A. M.	−1 foot.		4.30 P. M.	+5 feet, ½ inch.
	P. M.	−8 inches.	October 1	8 A. M.	+4 feet, 11½ inches.
September 23	A. M.	−10 inches.		12.45 P. M.	+4 feet, 11½ inches.
	P. M.	−8 inches.	October 2	7 A. M.	+5 feet, 4 inches.
September 25	A. M.	−2 inches.		8.30 A. M.	+5 feet, 5½ inches.
	P. M.	+10 inches.		10.30 A. M.	+5 feet, 4½ inches.
September 26	A. M.	+4 feet, 10 inches.		2 P. M.	+5 feet, 4½ inches.
	2.45 P. M.	+5 feet, 3½ inches.	October 3	7 A. M.	+5 feet, 5½ inches.
	3.15 P. M.	+5 feet, 4 inches.		3.30 P. M.	+5 feet, 6½ inches.
	3.45 P. M.	+5 feet, 4 inches.	October 4	7 A. M.	+6 feet, 7½ inches.
September 27	8 A. M.	+5 feet, 9½ inches.		10 A. M.	+7 feet, 6 inches.
	10.15 A. M.	+5 feet, 8½ inches.		3 P. M.	+7 feet, 9 inches.
	4.45 P. M.	+5 feet, 3 inches.	October 5	3 P. M.	+6 feet, 3 inches.
September 28	8.45 A. M.	+4 feet, 7½ inches.	October 6	9 A. M.	+5 feet.
September 29	9 A. M.	+4 feet, 8 inches.		3 P. M.	+4 feet, 4 inches.
	10 A. M.	+4 feet, 8 inches.	October 7	9 A. M.	+4 feet.
September 30	8.30 A. M.	+5 feet.	October 8	7.50 A. M.	+4 feet.
	11 A. M.	+5 feet.	October 9	8.30 A. M.	+3 feet, 8 inches.

NOTE.—From September 20 to 25, inclusive, and from October 5 to 9, inclusive, readings were measured from mark set at each reading, and were rather inaccurate. From September 26 to October 4, inclusive, readings were made from a graduated gauge established at the bridge site. This gauge was destroyed by a shore cable on October 4 and was not replaced.

VELOCITY.

September 21. One current measurement, very rough, at lower ford center of channel, gave 3½ feet per second.

September 26. At bridge site, mean of three measurements near north shore gave 4.35 feet per second. Mean of two measurements near center of channel gave 3.7 feet per second.

October 7. At bridge site, fifth boat from south shore (two measurements) 3.71 feet per second.

Eighth boat from south shore (five measurements) 3.73 feet per second.

Fourteenth boat from south shore (five measurements) 3.6 feet per second.

Fifth trestle from north shore (two measurements) 3.28 feet per second.

ORDERS FOR BRIDGE GUARD.

The guard will consist of one non-commissioned officer and twelve privates. The guard will be mounted daily at 6 P. M.

From 6 P. M., until 6 A. M., one private will be on duty on the bridge at all times. It shall be his duty to see that no one comes upon the bridge (except members of the guard) without proper authority, and to guard the bridge from drift or other danger.

From 6 A. M., until 6 P. M., two privates will be continually on duty, No. 1 at north end of bridge, No. 2 at south end of bridge. They will be equipped with carbine, belt, and six rounds of ball cartridge.

The orders for Nos. 1 and 2 from 6 A. M., to 6 P. M., are as follows:

To notify civilians who desire to cross the bridge that they do so at their own risk, and to prevent their loitering upon the bridge.

To direct all foot troops crossing the bridge to march in columns of twos at broken step.

To direct all mounted troops to dismount and cross the bridge in column of twos, horses outside and men leading in middle of bridge.

To direct artillery or wagon trains to cross with an interval of one bay between teams.

To require pack animals to be led as prescribed for mounted troops.

No loose horses or cattle will be allowed on the bridge at any time.

Enlisted men not on duty will not be allowed to loiter on the bridge.

Officers will be permitted to cross mounted if they so desire.

Care will be taken to see that no team, horse, or body of troops be permitted to come upon the bridge for crossing while another such is crossing in the opposite direction.

Guards will render the customary salutes of sentinels.

Guards will, at all times, make every effort to protect the bridge from drift or other danger, and will turn out the entire guard if the danger be great.

The guard will visit camp for its meals, leaving two men in the guard tent in addition to the sentinels on post.

Guards will halt troops crossing the bridge if violent oscillations are observed, until the oscillations cease.

During passage of the bridge by any troops one man (in addition to

sentinels on post) will be in the guard skiff below bridge ready to go to the assistance of any one who may fall off the bridge.

One member of the guard will at all times be kept within hearing of the telephone in the guard tent.

The diagonal bracing of the trestles will be slackened whenever rain begins to fall and tightened again when the bracing is dry.

(Signed) C. A. F. FLAGLER,
Captain, Corps of Engineers, U. S. Army,
Commanding Company C.

COMPANY D, 1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANSAS,
NOVEMBER 17, 1902.

THE ADJUTANT,
1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANSAS.

SIR: I have the honor to submit the following report of the work done by Company D, 1st Battalion of Engineers, at the Fort Riley maneuvers, and recommendations in reference to equipment.

The work of the company naturally comes under two heads, work done acting as infantry and work as engineers.

As the work as infantry has no bearing upon the subject of equipment it may be briefly dismissed by stating that the company, acting as infantry, took part in the following exercises: September 24, as part of outpost for an army corps; September 27, as part of advance guard for a division; September 29, contact problem for all arms; October 6, after 10 A. M., as part of line for defense of intrenched position; October 7, as part of tactical exercise for a division.

The engineer work of the company comprised foot and mounted reconnoissance and drafting; construction of 40-foot trestle bridge across Three Mile Creek with material of bridge train, using a Birago trestle for the middle support; cutting approaches to fords on Three Mile Creek, and south approach to ponton bridge across the Kaw River; construction of typical sections of various forms of intrenchments, viz, skirmish trench, kneeling trench, standing trench, complete trench, shrapnel trench, and shell trench, and also of gabion, hurdle, sandbag and sod revetments, for illustration of lecture on intrenchments; tracing and supervising construction of intrenchments on the right of the defensive position occupied by the Blue forces under command of Major Leach, October 6, and constructing that part of intrenchments occupied by Company D. (A special

report of the work done on this day has been heretofore submitted.) In addition, details from the company were furnished Captain Flagler from time to time to assist Company C in constructing the ponton bridge across the Kaw River.

The engineer equipment of the company was transported to Fort Riley by one escort wagon and three pack mules and was composed as follows: For reconnoissance, 6 cavalry sketching cases, with necessary paper, pencils, erasers, etc.; for field fortification, 30 shovels, 12 picks, 1,000 sandbags, 3 gabion forms, 1,500 feet of tracing tape, 12 machetes, and 6 gabion knives, and for general use in road and bridge building and all other classes of engineering work, a miscellaneous assortment of tools.

With reference to this equipment the following suggestions and recommendations are submitted. For reconnoissance, the cavalry sketching case gave excellent results, but it is believed that this was due not only to the careful work of the observers and of the topographical officer but also to the excellent check afforded by the section lines, and that for general work a better and more accurate instrument can be devised. The equipment of each company should include for reconnoissance work, 6 sketching cases, 6 wrist watches, and the necessary instruments and supplies to complete field maps and reproduce them by blue printing. These instruments should include one small drawing board or table, one small blue-print frame, one set of drawing instruments, one triangular scale, one ruler, and one triangle.

The instruments and supplies for the larger and more elaborate map reproductions should be available at the engineer depot when required, but should not ordinarily form a part of the company equipment.

As this subject has been reported upon by the Battalion Adjutant, I will merely state that the necessary instruments for making the ordinary topographical signs would have expedited the work greatly and should be included at least in the depot outfit.

For field fortification, the tools carried in the tool wagon as part of the equipment should be limited to those necessary for use of the foot sections only, and should include about 250 sandbags 60 shovels (short handles), 30 picks, 12 bill hooks or machetes, and 3,000 feet of tracing tape in 150 foot lengths, each, marked every five feet and attached at one end to picket upon which it is wound. For general pioneer engineering work the tools should include 24 axes, 6 adzes, 4 cross-cut saws, 6 sledges, 12 iron wedges, 1 grindstone, 12 long-handled shovels, 6 mattocks, 3 cant hooks, 12 canvas buckets, 100 pounds assorted nails, 2 sets blocks and

falls, 6 crowbars, and 1 special set of carpenter tools in which the ordinary tools should be increased by 12 cutting pliers, 12 hand saws, 12 ship augers, one-half or five-eighths of an inch, depending size of drift-bolts and bolts carried, 6 wood augers, two inch; 12 chisels, two inch; 6 carpenter mallets, 12 steel squares, 1 cutter, to make dowel pins for two-inch holes; 12 two-foot rules, 12 hatchets, 6 hand axes, 4 tapes, fifty or one hundred feet; extra files, saw sets, and oil stone to keep these extra tools in order. A special tool chest or chests should be constructed for the transportation of these carpenter tools as the ones used at Riley are entirely unsuitable. What is needed is a chest with strongly-built trays so designated as to give ready access to the tools, yet hold them securely in place when packed for transportation.

In addition to these tools a small horseshoer's kit, and fitted shoes for all the draft mules should be provided.

The remainder of the load of the tool wagon up to the allowable limit of weight should be made up of drift bolts, bolts, nails, rope, and marlin. A special tool wagon should be provided, properly designed for convenience of loading and ease of access to tools, for the escort wagon is not suitable for the purpose. If, however, the escort wagon must be used for the present, I strongly recommend that a standard loading be developed by actual test, so that the unsatisfactory state of affairs experienced in handling these loads during the Riley maneuvers may be remedied as far as possible. It is to be remarked that the standard load and standard loading are both dependent upon the form of wagon used, and it is probable that the list of tools suggested will require modification. The engineer epuipment of the mounted section was carried on the pack mules and for two of these mules a standard load was adopted, which will need minor modifications, if any.

The loading for the other two mules intended for engineer material should be determined. In my opinion one of them should carry all the tools and supplies for demolitions; and the other, rough carpenter tools, folding cross-cut saw, nails and other supplies for bridge repair work. The efficiency of the mounted sections of the battalion could be increased and their administration simplified by the appointment of an assistant veterinarian with the rank and pay of sergeant, to perform the duties of stable sergeant and look after the health of all the animals, and the appointment of a farrier and horseshoer for each section, to have the rank and pay of corporal. It is also thought that the enlistment of special men as teamsters for the bridge train with necessary increased compensation, say

$25 per month, to make their pay equal to that of similar quartermaster employees, would add materially to the efficiency of the battalion.

Very respectfully,

J. B. CAVANAUGH,
Captain, Corps of Engineers,
Commanding Company D.

APPENDIX NO. 8.

HDQRS. 1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANSAS,
NOVEMBER 4, 1902.

MAJOR SMITH S. LEACH,
CORPS OF ENGINEERS,
FORT LEAVENWORTH, KANSAS.

SIR: I have the honor to report on the photographic and map reproducing departments of the 1st Battalion of Engineers, as follows:

PHOTOGRAPHIC OUTFIT.

1. There was carried to Fort Riley a complete outfit for making 5 by 7 to 10 by 12 photos. This outfit had been furnished by the Engineer Department, and although in store at this post for several months it had not been tested or thoroughly examined. This, of course, was due to the fact that this battalion had barely sufficient storage room for this property in its original package, there being no place available where it could be opened and examined. For this reason a number of defects were found after the setting up of the apparatus at Fort Riley.

2. *Cameras.*—The large camera is a 10 by 12 portrait camera mounted on a transit tripod, wholly unsuited for outdoor work, as the mounting of the camera makes it unwieldy. In a light wind there is so much vibration that photographs can not be made. The shutter is too slow for any moving object. The lens, however, is excellent.

The small camera, a 5 by 7 Premo, Sr., is a good camera for outdoor work but the shutter was found to be broken, and considerably over seventy-five per cent of the plates exposed were destroyed. This shutter has been sent off for repair.

A copying camera should be provided for copying maps and sketches. It should be sufficiently long to permit copies of same size as original. There should be provided also a stand for the copying camera. This should be collapsible, and so arranged that it will pack into a convenient shaped package.

3. *Plates.*—The packages of plates were in good condition except where tacks had been driven through the cover into the edges of some of the plates, each tack breaking one or two plates. This was due to carelessness in fastening the address card on with tacks long enough to go entirely through the wood of the cover and into the plates. It is suggested that great care be taken in driving nails or tacks into boxes containing plates. When plates are to be kept some time, or when it is probable that the boxes will get wet, the plates should be sealed in tin.

4. *Paper.*—The paper was in good shape, packed in tin. The tropical solio seems to be the best paper for use in the field, but some velox and bromide paper should be carried. In packing, it would be better to pack each gross in a separate tin box. Tin boxes should be marked with contents.

5. *Chemicals.*—Several important chemicals, although in stock, were not carried. A complete assortment should be carried for any possible contingency. All salts should be packed in bottles or tin cans.

6. *Apothecaries' scales.*—The scales carried were small balances, weighing only up to one-quarter of an ounce, apothecaries. Those provided for the photograph outfit should weigh up to two pounds, avoirdupois.

7. *Dark tent.*—The tent provided was a small canvas tent with poles, allowing the passage of more white light than a new hospital tent. A portable dark tent is absolutely needed and it is believed that such a tent can be obtained, as the Signal Corps provides a good dark tent.

8. *Trays, graduates, bottles, etc.*—Glass bottles and graduates can be carried in the field if properly packed. An ample supply of agate and rubber-ware trays should be provided capable of nesting, also ample supply of bottles, graduates, funnels, etc., to replace those broken.

9. *Lights.*—The ruby lantern is of good quality. It is thought, however, that an acetylene burner will be more useful in the field than an oil burner, assuming, of course, that an ample supply of the carbide is carried. An ordinary white light, burning acetylene or oil, should also be provided.

10. *Work tables, etc.*—None were provided, but the photographic outfit should include two 6 by 2 foot collapsible work tables, so arranged that they can be packed into conveniently shaped packages.

11. *Packing cases.*—All photographic apparatus and materials should be packed in cases or crates. These cases and crates should have hinged sides and staples and padlocks; should be strong and as light as is consistent with proper strength; should be of as nearly uniform size and shape as possible to permit close packing. Each case or crate should have countersunk handles and should be conspicuously marked "1st Bat-

talion of Engineers," "photograph," and in smaller letters on the lid there should be marked the contents. A castle surmounted by a "1" should also be stamped on each case and crate.

The following cases and crates should be provided:

One camera case for each camera and its plate holders and lens.

One canvas case with straps for each tripod.

Two cases for bottles of chemicals, with interior frames to hold bottles firmly in place.

One case of chemicals in bulk.

One case for hyposulphite soda.

One case for graduates, funnels, and a nest of trays, and a compartment for apothecaries' scales.

One case for plates and paper.

One case for sundries (as scissors, knives, clips, trimming glass, drying racks, hammer, tacks, screw driver, screws, twine, matches, etc.)

One case for dark tent.

One case for hospital tent.

One crate for (print washing) can and rubber buckets.

One case for lamps.

One crate for folding camp stools (with four stools.)

12. *Tent.*—A hospital tent should be provided as part of the photographic outfit, and it should not be counted as part of the battalion tentage.

13. *Spring wagon.*—It is believed that the photo outfit can be carried in a spring wagon, but in any event a spring wagon would be of great assistance in carrying around the photographer with his camera, plates, etc. At Fort Riley it was impossible to obtain all the views desirable for lack of such a wagon.

14. *Sundries.*—Before taking the field with the photographic outfit a careful list should be made of all sundries that may be needed, and these should be liberally provided.

MAP REPRODUCTION.

15. *Drawing boards.*—Four of the folding drawing board stands were carried and found to be very convenient. No change is suggested.

16. *Drawing instruments.*—One large set of drawing instruments and small set were carried. The instruments in these boxes were insufficient for the four or more draftsmen who were nearly continuously at work. There were lacking also road pens, proportional dividers, etc., and map measurers. It is recommended that four drawing sets be carried, each set to contain one large right line pen, one small right line pen, one

dividers, large; one bowspring dividers, one compass with lengthening bar and pen and pencil points, one bowspring pen, one bowspring pencil, one road pen, one proportional dividers, one railroad pen, one contour pen, one crowquill penholder with pens, one semicircular G. S. protractor, four celluloid triangles (one large 45 degree, one small 45 degree, one large 30 degree, one small 30 degree); one set celluloid irregular curves, one steel straight edge, one celluloid straight edge, one wooden straight edge, one T square, two boxwood scales, one map measurer, two dozen thumbtacks, two bottles of black ink, and one red and one blue, two penholders, four dozen assorted pens, two steel ink erasers, two rubber ink erasers, two rubber pencil erasers, one dozen assorted pencils, one small wooden pantograph. These articles to be neatly packed in a suitable case.

It is recommended also that a fifth case of instruments be provided, to contain a small wooden pantograph, one full circle swing-arm protractor, reading minutes, one beam compass complete, three steel triangles, two steel straight edges, four celluloid straight edges, four wooden straight edges, one gross of thumbtacks, one gross of pencils, assorted; one dozen of penholders, two boxes of pens, six crowquill penholders, one box of crowquill pens, two dozen bottles of black ink, one dozen bottles of ink, assorted colors; the lettering device and device for topographic symbols. (See par. 32.) To be packed as above.

17. *Blue print frame.*—The large blue print frame was found to be very useful, but it is thought that a smaller frame should also be carried on account of the greater ease in handling a small frame. The large frame, however, should always be carried. Instead of the loose cotton backing, a stiff felt pad should be provided. There should be carried a stand for the blue print frame. It is possible that a combined packing case and stand can be made. If not, each will have to be provided.

18. *Washing trays.*—One large zinc tray and one medium size japanned tray were carried. They could hardly be improved on. At least two of the larger trays should be carried and one of the smaller.

19. *Zincographic outfit.*—A portable zincographic outfit should be provided. At present the battalion has no method of reproducing maps at night or in cloudy weather.

20. *Hectograph.*—A hectograph should be provided. This will be found useful in reproducing rough sketches.

21. *Neostyle.*—A rotary neostyle was carried, but was not used. It is thought, however, that it should be carried as part of the map reproducing outfit.

22. *Preserving tubes.*—Five or six of these tubes were carried and found to be useful. The covers are not well made and were nearly all knocked off. A better type should be provided in the future. At least six of each size (about 44 inch and 26 inch) should be carried.

23. *Drawing paper.*—Both the backed and the plain drawing paper should be carried as well as paper for the sketching cases. Paper should be in rolls of 24 inch and 42 inch paper.

24. *Tracing linen.*—Should be 24 inch and 42 inch, and should be carried in preserving tubes.

25. *Blue print paper.*—That carried was not fresh and did not make good prints. The paper should be absolutely fresh and liberally supplied. The proper sizes are 24 inch and 42 inch. Some blue print cloth should be carried (possibly as much as one-half.)

26. *Black process paper.*—Some of this paper was carried to Fort Riley and tried there. The paper was of such poor quality that it could not be handled—even in unrolling, it would tear, and it was absolutely impossible to print with it. There is no reason why a heavy paper should not be sensitized with this preparation. If a good paper can be had several rolls should be carried. Sizes, 24 inch and 42 inch.

27. *Brown process paper.*—This paper was tried at Fort Riley for both negatives and positives, but not with great success, possibly because of lack of experience in handling. It is certain that this paper will produce good results and it should therefore be carried. Rolls of 24 inch and 42 inch.

28. *Lights.*—Four good lamps should be provided, with shades, and with rochester oil or acetylene burners.

29. *Tent.*—A hospital tent should be provided as part of the equipment of this department, not to be regarded as part of the battalion tentage.

30. *Wagon.*—An escort wagon should be provided exclusively for the map reproduction outfit, and such surveying instruments as may be carried.

31. *Packing cases and crates.*—The remarks in paragraph 12 apply also to the cases and crates for the map reproduction outfit. The marking should be the same as given in paragraph 12, except that the word "photograph" must be replaced by the word "map."

The following crates and cases are needed:

Five cases for "drawing sets" (contents as given in paragraph 16); four to six cases for drawing paper, tracing linen, blue, black, and brown print papers, manila paper and blotters; four crates for drawing boards, one

crate for trays, two crates for blue print frames, one crate for print washing can, one case for hectograph outfit, one case for neostyle, one case for stationery for neostyle and hectograph, one case for hectograph, cases for zincographic outfit, two cases for lamps, one case for hospital tent, one case for sundries.

32. *Lettering and topographic symbols.*—An outfit should be provided for lettering drawings and for making topographic symbols. (As used on the Mississippi River survey.)

WORK DONE BY THESE DEPARTMENTS AT FORT RILEY.

33. The battalion photographer made about thirty good negatives, but probably at least seventy-five exposures were made, the rest being failures due to defects in the cameras. Some prints were made from these plates, but none were sent out, as complete sets had not been made. Full sets will, however, be sent to the Adjutant General, the Chief of Engineers, the Division Commander and others.

34. Tracings, in eleven sheets, were made of the route sketch of the march of the battalion to Fort Riley, and three sets of blue prints were sent to the Division Commander.

A tracing was made of reconnoissance sketches (made by the battalion) of the Fort Riley reservation and adjacent country. Blue prints of this were sent to the Division Commander and the Assistant Secretary of War.

Two of the enlisted draftsmen prepared sketch for Colonel Wagner's lecture.

Very respectfully,

H. BURGESS,
1st Lieut., Corps of Engineers,
Adjutant, 1st Battalion of Engineers.

No. 6.
OCCASIONAL PAPERS,
ENGINEER SCHOOL OF APPLICATION,
UNITED STATES ARMY.

HISTORICAL SKETCH

OF THE

FIRST BATTALION OF ENGINEERS

DURING ITS TOUR ABROAD.

SMITH S. LEACH,
MAJOR, CORPS OF ENGINEERS, U. S. ARMY, COMMANDING.

PRESS OF THE ENGINEER SCHOOL OF APPLICATION,
WASHINGTON BARRACKS, WASHINGTON, D. C.
—1903—

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HDQRS. 1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANS.,
June 9, 1903.

THE ADJUTANT GENERAL, U. S. ARMY,
Washington, D. C.
(Through Military Channels.)

SIR: In compliance with instructions contained in letter from the Adjutant General's office of November 11, 1902, I have the honor to submit herewith an historical sketch of the operations of the 1st Battalion of Engineers.

This battalion was organized in May and June, 1901, from Companies A, B, and E (old) Battalion of Engineers. On account of this fact and of the nature of the service performed by the companies of this battalion subsequent to its formation, which service required that all companies be detached from battalion headquarters, it is thought that it will be more advisable to submit a brief account of the formation of the battalion, and submit a sketch for each company separately. This method is followed in the paper herewith.

Very respectfully,

SMITH S. LEACH,
Major, Corps of Engineers,
Commanding 1st Battalion of Engineers.

1st Indorsement.

HDQRS. 1ST BATTALION OF ENGINEERS,
FORT LEAVENWORTH, KANS.,
June 9, 1903.

Copy respectfully furnished to the Chief of Engineers, U. S. Army.

SMITH S. LEACH,
Major, Corps of Engineers,
Commanding 1st Battalion of Engineers.

2d Indorsement.

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 26, 1903.

1. Respectfully referred to Major Edward Burr, Corps of Engineers.

2. In the opinion of the Chief of Engineers, this well-written and authentic history of the foreign service of the 1st Battalion of Engineers is well worth printing.

* * * * * * *

BY COMMAND OF BRIGADIER GENERAL GILLESPIE:
FREDERIC V. ABBOTT,
Major, Corps of Engineers.

HISTORICAL SKETCH OF THE 1ST BATTALION OF ENGINEERS DURING ITS TOUR ABROAD.

The organization of this battalion was effected under authority of G. O. 22, Headquarters of the Army, A. G. O., Washington, February 26, 1901, Major Clinton B. Sears, Corps of Engineers, being assigned to command by G. O. 79, Division of the Philippines, Manila, April 26, 1901. The former orders prescribed that the 1st Battalion of Engineers should consist of four companies, designated as Companies A, B, C, and D, and that it should be formed from the three companies of engineers, A, B, and E, then on duty in the Philippines, a new company to be formed by transfers from the three existing companies and the designation of Company E to be changed to Company C. Officers were assigned to companies of the battalion by S. O. 55, Headquarters of the Army, A. G. O., Washington, March 8, 1901.

Major Sears assumed command of the battalion on May 16, 1901, and appointed the following staff and non-commissioned staff:

Adjutant, 1st Lieutenant Harry Burgess, Corps of Engineers; Quartermaster and Commissary, 1st Lieutenant Sherwood A. Cheney, Corps of Engineers; Sergeant Major, Truman Organ, Company E; Quartermaster Sergeant, William Harer, Company E.

The Adjutant and Sergeant Major reported for duty as such on May 30, 1901; the Quartermaster and Commissary on September 28, 1901, and the Quartermaster Sergeant on June 18, 1901.

The battalion headquarters (the Battalion Commander, Adjutant, and Sergeant Major only) was established at Santa Lucia Building, Malacon Drive, Manila, and remained there until October 2, 1901.

On July 20, 1901, Company A, under command of Captain W. E. Craighill, sailed for the United States.

On October 1, 1901, Captain George A. Zinn took command of the battalion, Major Clinton B. Sears being relieved by Paragraph 1, S. O.

248, Headquarters Division of the Philippines, Manila, P. I., September 20, 1901. Headquarters of the battalion was established in Cuartel de Malate, October 2, 1901, and remained there until the battalion went aboard transport to return to the United States.

On October 18, 1901, the battalion, consisting of battalion headquarters and 3 companies (4 officers and 234 enlisted men), sailed for United States on transport *McClellan*, arriving at New York City, December 23, 1901. Battalion headquarters and Companies B and D proceeded to Jefferson Barracks for station; Company C, to West Point, N. Y.; Company A, upon its arrival in the United States, was assigned to duty first at Willets Point, N.Y., and subsequently, on September 3, 1901, at Fort Leavenworth, Kans.

Officers on duty at battalion headquarters: Major Clinton B. Sears, Corps of Engineers, May 16, 1901, to October 1, 1901; 1st Lieutenant Harry Burgess, Corps of Engineers, from May 30, 1901; 1st Lieutenant S. A. Cheney, Corps of Engineers, from September 28, 1901; Captain George A. Zinn, Corps of Engineers, October 1, 1901, to January 18, 1902 (in addition to his duty as Commanding Officer, Company B.)

Detailed history of companies follows:

COMPANY A.

Company A, consisting of one 1st Lieutenant, one additional Second Lieutenant, and 60 enlisted men, left Willets Point, N.Y., for San Francisco, Cal., on May 24, 1898, 1st Lieutenant C. P. Echols, Corps of Engineers, in command. The company arrived at San Francisco and went into camp at Camp Merritt, May 29, and was assigned to the 1st Brigade Philippine Expeditionary Forces, under command of Brigadier General Miller.

Captain W. C. Langfitt, Corps of Engineers, arrived and took command of the company June 2, and remained with the company until June 20, when he was relieved, having been appointed Major of Volunteer Engineers. Enlistment to war strength (146) was authorized and recruiting office established in San Francisco on June 8, and the enlisted strength of the company increased to 122. Additional 2d Lieutenant R. D. Kerr, Corps of Engineers, joined the company June 18. On June 14, a detachment of 20 men, commanded by 2d Lieutenant W. D. Connor, Corps of Engineers, left San Francisco for Manila on steamer *China* and arrived in Manila Bay July 16, landed at Cavite Arsenal the following day and remained there until July 29, when it moved to Camp Dewey, near Manila, where it remained until joined by the company.

The company with present strength of one 1st Lieutenant, one additional 2d Lieutenant, and 100 enlisted men, left Camp Merritt June 26

to join third expedition to the Philippines under command of Brigadier General MacArthur, and embarked on the *Indiana* same date, sailed on June 27, arrived at Honolulu July 6, and sailed for Manila July 8, where it arrived July 31. Additional 2d Lieutenant R. D. Kerr died July 21, and was buried at sea July 22, latitude 20° 48′ north, longitude 15° 18′ east. During most of the voyage daily drills were held, viz, signal, calisthenics, and theoretical engineering.

The company landed at Cavite Arsenal August 1, and went into temporary quarters until August 7, when it was ordered to Camp Dewey, where it remained until August 13. During the absence of its own officers from August 2 to August 6, 2d Lieutenant P. H. Mullay, 14th Infantry, had command of the company. While in Camp Dewey the company constructed a portable trestle bridge 180 feet long, which was carried to the front on August 13, but was not needed as the permanent bridges were not destroyed.

On August 13 the company was divided into two platoons, the first, commanded by Lieutenant Connor, reported to General Greene on the left, and the second, commanded by 1st Sergeant James Reardon, reported to General MacArthur, and both platoons entered the city of Manila with the first troops, the first platoon being quartered in the Insular Tobacco Factory at Binondo, Manila, and the second in the Cuartel de Malate, at Malate, Manila. Lieutenant Echols, who had been in hospital at Cavite since the company arrived in the Philippines, joined the company on the evening of the 13th, and on the 14th the second platoon joined the first at the Insular Tobacco Factory, where the company remained until December 29, when it moved to quarters in the Convent de Malate, Manila.

In August, a reconnoissance of the battlefield was made and a map prepared. A detachment of Sergeant Thomas F. Kennedy and 26 other enlisted men was engaged in clearing the Pasig River for navigation (under Ensign W. A. Moffitt, U. S. Navy), from August 28 to October 31.

Lieutenant Connor was relieved August 23 from duty with the company per S. O. 33, Headquarters Department of the Pacific, series 1898.

During the period from August 14, 1898, to February 4, 1899, the company was employed in making a detailed reconnoissance of Manila and vicinity. Sergeant Fisher with a detail of four privates from the company, while on reconnoissance duty near the insurgent's lines, were captured by them on January 29, 1899, and taken to Malolos where they were confined until February 3, when they were released and permitted to join the company.

September 3 and 4, 1898, no officer was present for duty with the company.

September 5 to 7, the company was commanded by 1st Lieutenant

M. G. Krayenbuhl, 3d Artillery.

From September 8, 1898, to March 5, 1899, the company was commanded by 1st Lieutenant W. G. Haan, 3d Artillery.

The company was assigned to the 2d Division, per G. O. 17, Headquarters Department of the Pacific and 8th Army Corps, series 1898.

Lieutenant Echols was relieved from duty with the company November 11, 1898, per S. O. 104, Department of the Pacific and 8th Army Corps.

On February 5, 1899, the company, commanded by Lieutenant Haan, took part in the attack on the insurgents, moving out on the right flank of General King's brigade, of the 1st Division, starting from Blockhouse No. 12, about 8:20 A. M., and took possession of the heights beyond San Pedro Macati at 10:10 A. M., and occupied the town at 11 A. M.

During this attack and while advancing, Colonel Smith, one Lieutenant, and 13 enlisted men of the 1st California Infantry joined the company, they having been cut off from their command, which arrived at San Pedro Macati about 45 minutes after the company had taken possession. Colonel Smith's regiment having arrived our outposts were relieved and the company returned to its quarters.

On February 15 the company, having been directed to make a reconnoissance outside the lines, became a part of an attacking force of the companies at Pateros; the company had the right of the line. Artillery was at first used and the order was to advance immediately after. The company advanced in the firing line, having a support of three companies. The insurgents were discovered and attacked, and for two hours kept under fire, but no support came to the assistance of the company and as there was no other firing, the company was withdrawn. It was afterward learned that the order to retire had been given just as the company had advanced and it was consequently left alone in the attack, but it had such a strong position that at no time did the insurgents show themselves without getting such a fire that they were compelled to withdraw to cover.

In February a detachment surveyed the country from Manila to San Pedro Macati, and the road from there to Pasig.

2d Lieutenant W. P. Wooten, Corps of Engineers, joined the company February 27, per S. O. 293, A. G. O., December 13, 1898.

Captain F. R. Shunk, Corps of Engineers, joined the company February 27, per S. O. 267, A. G. O., November 11, 1898.

On March 28 Captain Shunk, with a detachment of 25 enlisted men, joined General MacArthur's division in the northern advance. The detachment was employed in repairing roads and bridges destroyed by the retreating insurgents; constructing rafts, rope ferries, ponton bridges, and

building new bridges according to the kind and amount of material that could be obtained, and in reconnoissance work. This work was performed chiefly in the night, as it was essential that the ammunition and supply trains be kept in touch with the firing line. During the day and when not engaged in engineer work the detachment participated in several engagements, and on several occasions at night it passed beyond the outposts to reconnoiter and to repair the railroad to enable the armored cars to keep up with the firing line. During this period the advance was rapid until Malolos was reached.

From the latter part of March Lieutenant Wooten, with a detachment of 25 men from the company, also took part in the same advance under the immediate orders of General Wheaton. The work done by this detachment was similar in character and extent to that outlined above for Captain Shunk's detachment.

Upon arrival at Malolos, Captain Shunk was ordered to return with his detachment to take station again in Manila—at Malate Convent.

The other detachment continued with the northern advance. The first serious delay was encountered three miles north of Malolos, where a steel railroad bridge spanning the Bag Bag River had been destroyed, one 80-foot span having been detached and dropped a distance of thrity feet into the river. Not having facilities to raise the span, the break was crossed by the construction of a substantial trestle bridge. The next difficulty was encountered at Calumpit where the truss railroad bridge across the Rio Grande de la Pampanga had been rendered useless by the insurgents by removing the fish plates, throwing into the river the rails, burning the ties and removing the roadway bearers. Want of proper facilities and necessity for prompt passage of this river rendered impossible the repair of this bridge at that time, and a rope ferry was constructed; one detail cut down approaches, another stretched the line, another procured material, and the remainder constructed the raft, which consisted of four layers of bamboo, the pieces of adjacent layers at right angles, the whole well lashed, and 35 feet wide and 48 feet long and having a safe carrying capacity of 10,000 pounds. The first load of artillery pieces was transported across the river within three hours from the time of setting about the construction of the raft. The width of the river here is about 650 feet and the river is about 20 feet deep.

A similar condition was found in May between Apalit and Santo Tomas, where a steel railroad bridge had been destroyed by dropping one end of a span into the Santo Tomas River. The span was replaced by the construction of a substantial bridge, the trestles resting on the inclined

truss as it lay, the dropped end resting on a secure foundation.

2d Lieutenant H. W. Stickle, Corps of Engineers, joined the company April 23.

During the month of May, in addition to the Santo Tomas bridge repairs, the detachment, under Lieutenant Wooten, accomplished the following work:

1. Building wagon bridges between Calumpit and San Fernando via Apalit, and repairing wagon road. Two bridges about 100 feet each were built entire out of lumber obtained mostly from the church and convent of Apalit. The detachment had no transportation and hauled material on impressed bull carts. This road was for about three weeks the only supply line between Calumpit and San Fernando.

2. The rope ferry at Calumpit was kept in working order.

3. Nearly two miles of railroad track had been destroyed between Santo Tomas and Calumpit, and the roadbed much torn up in the construction of earthworks. By May 20 the road was opened and flat cars pushed by coolies were then used to bring supplies until other rolling stock could be secured. All the other rolling stock at that time was either south of the Rio Grande or in possession of the insurgents north of San Fernando, the railroad bridge at Calumpit being impassable for trains.

Having arrived in San Fernando the advance was halted for reinforcements, and to allow the men to recuperate as they had been under constant fire for about three months. During the stay in San Fernando the insurgents made several night attacks, but in each case were repulsed with severe loss.

On June 10 and 11 Lieutenant Stickle accompanied General Wheaton in General Lawton's advance against insurgents at Las Pinas and Paranaque. June 14–19 a detail of 27 enlisted men under Lieutenant Stickle constructed a temporary bamboo bridge at Paranaque over a stream about 300 feet wide. During this time the Zapote River bridge, damaged by fire by the insurgents, was repaired.

June 20–July 15, a detail of nine enlisted men under Lieutenant Stickle built a trail bridge for use across the Bag Bag River at Quingua, 25 Chinese laborers and about the same number of natives being hired to construct the approaches, which were made from high steep banks. The raft was of catamaran form, both boats and flooring being made completely by the detail, and mostly of native lumber. The raft was 30 feet by 16 feet when completed. The width of the stream was about 200 yards and the distance between anchorages about 250 yards. The cable used was one inch of steel and was raised and lowered by shears on each bank and made taut by an improvised field capstan on one bank, the

shears finding use particularly in the frequent cases of sudden rising of the river at this point, due to heavy showers in the mountains a few miles distant where this stream had its source.

During August a detail of eight enlisted men under Lieutenant Stickle built a rope ferry for the river at Paranaque, the temporary bridge having been washed away. This raft was built in catamaran fashion on two cascos hired for the purpose. In August, also, the cable at Quingua having broken, the same detail put in a new cable. The service rendered by Private Duncan C. Morrison in stretching this cable was hazardous and was skillfully performed.

In addition to its engineering duties the detachment under Lieutenant Wooten was assigned to the armored car during the advance from San Fernando to Calulut and during the battle and capture of the latter place on August 9, 1899, occupied the center of the line.

During August and September the company was very much scattered, being divided into small details for various emergency work in the Island of Luzon. This included the construction of a bridge by a detail under the supervision of Captain Shunk at Imus. This was a high trestle bridge about 75 feet long and built of lumber shipped by water from Manila. In the latter part of September the company was ordered to occupy part of the line from Pasay to San Pedro Macati. It was assigned a position at Culi Culi, near the center of the line, which it held for about forty-eight hours, acting as infantry, Captain Shunk commanding.

From October 2 to 31 a number of enlisted men of Company B, varying from 30 to 61, were attached to Company A.

On October 4 the company, with a detachment of Company B, Captain Shunk commanding, was directed to take up a position and form part of a battalion with two companies of infantry at Paranaque ferry and connect with the infantry at Pasay, this being a line of about four miles for three companies to hold. This duty was performed by patrolling and continued three days. In the meantime the ferry and its approaches were put in good order.

October 7–14 the company took part in General Schwan's expedition in Cavite, under Captain Shunk, October 7, and Lieutenant Stickle the remainder of the time. The operations of the company during this time may be outlined as follows:

1. Construction of rope ferry across Bacoor River during the night of October 7, and manning boats for crossing the infantry.

2. The repair of roads for the main column from the Bacoor River to Dasmarinas October 8 to 12.

3. The work of a detachment of the company under Lieutenant Stickle in the column under Major Bubb, from Rosario to San Francisco de Malabon on the left bank of the Canas River October 9 to 11, consisting of:

a. Construction of raft for artillery and wagons and manning boats for infantry to cross the Canas River near Rosario.

b. Repairing of roads and trails left bank of river.

c. Engagement with the enemy in which one private was wounded, near Santa Cruz de Malabon.

d. Reconnoissance and scouting duty.

4. Reconnoissance from San Francisco de Malabon to San Gaviel October 11, and from Dasmarinas toward Silang October 12.

On October 16 the detachment under Lieutenant Wooten took part in repelling a night attack on Angeles and constructed emplacements for artillery near the Angeles bridge. This detachment was at this time continually engaged in foot reconnoissance, repairing railroads, wagon roads, and bridges. During the month of October small squads of non-commissioned officers and privates of the company were at different periods in charge of squads of Chinese laborers constructing and repairing various roads in the vicinity of Manila.

In October the company received instruction in foot reconnoissance and had some infantry drills.

1st Lieutenant S. A. Cheney, Corps of Engineers, joined the company November 3, per S. O. 302, Headquarters Department of the Pacific and 8th Army Corps, series 1899, and continued on duty with the company until relieved December 24, 1899, per S. O. 352, same headquarters and series.

A detachment of 2 officers and 25 enlisted men under Lieutenant Cheney, accompanied General Wheaton's advance by water on San Fabian on November 4, 1899. The work of this detachment was continuous and arduous, and exposure to inclement weather severe. It consisted in unloading mules and horses from transports anchored about a mile from shore, unloading supplies on the beach, repair of roads, building of a bamboo raft and its use in a rope ferry across the San Fabian River, the repair of telegraph and telephone lines from San Fabian to Tayug and participation in the firing line.

Lieutenant Cheney accompanied the expedition of the 13th Infantry to the north of San Fabian in November and took part in an engagement south of Santo Tomas. Lieutenant Stickle of this detachment accompanied one company of the 36th Infantry as engineer officer on an expedition to Salasa,

and took part with that company in the attack on and capture of the town of Mangatarem in the latter part of November.

Lieutenant Stickle was relieved from duty with this detachment December 1 and returned to Manila.

On November 5 Lieutenant Wooten's detachment took part in the battle of Magalang, and from there went to Mabalacat and constructed a trestle bridge to replace an arch bridge which had been blown out by the insurgents. On November 11 this detachment took part in the battle of Bambam, after which it joined General Wheeler's column in the advance on Tarlac, November 12–14, repairing or constructing bridges injured or destroyed by insurgents. In November this detachment repaired about two miles of Manila & Dagupan Railroad which had been completely washed away by the Tarlac River; 800 feet of trestle was constructed of crib-work which was afterward used by the Manila & Dagupan Railroad for over a year, the work being accomplished in ten days and going on night and day. About November 24 this detachment moved to Calasiao and commenced the construction of the railroad from that point to Dagupan, this portion, about two miles, having been completely destroyed. Some rolling stock which had been run off into the Calasiao River was recovered. In this work the detachment was assisted by a detachment from Company B, under Lieutenant H. B. Ferguson, Corps of Engineers.

Lieutenant Cheney's detachment returned from San Fabian to Manila and joined the company about December 20.

Lieutenant Stickle accompanied a detachment of Company B under Lieutenant J. C. Oakes, Corps of Engineers, from December 17 to December 30, repairing ferries and bridges from Arayat to Cabanatuan via San Isidro and returned to Manila.

Lieutenant Wooten was relieved from duty with the detachment and joined the company the latter part of December, leaving the detachment at Bayambang.

Companies A and B were united January 1, 1900, and divided into two detachments, one under Lieutenant Ferguson and accompanied by Lieutenant Wooten, and the other under Lieutenant Oakes, accompanied by Lieutenants Cheney and Stickle.

They first advanced into Cavite Province by way of Laguna de Bay as a part of General Schwan's command. The second advanced into Cavite Province from Manila via Paranaque, Baccor, Imus, Dasmarinas, to Silang, where the columns joined on January 10. The work of these detachments consisted in the emergency repair of roads and bridges, the second detachment continuing its work from Silang to Naic via Indan.

Numerous route sketches and reconnoissances were made by these detachments. The second detachment returned to Manila the latter part of January, and the first detachment on February 7.

Lieutenant Stickle was assigned to command the detachment at Bayambang, which had been placed under the immediate command of the Commanding General of the 2d Division, General MacArthur.

Temporary repairs to roads and bridges were made by this detachment as follows:

January 27–28. Panique to Cuyapo via Anas, 10 miles.

January 29–31. Panique to San Juan de Guimba via Pura, 13 miles. On this road a trestle bridge 50 feet long was built with lumber from churches in Pura.

February 3–9. Bautista to San Jose via Rosales, Humingan, and Lupao, 42 miles.

February 10–13. Humingan to San Nicolas via San Quintin and Tayug, 15 miles. This included much corduroying of extremely bad roads.

February 14–15. Tayug to Rosales via Santa Maria, 14 miles.

February 17–March 6. Lieutenant Stickle with part of the detachment inspected roads and submitted reports and estimates for temporary repairs to roads and bridges on Dagupan-Tayug line of communication, with all cross roads, traveling 140 miles.

March 7–18. This detachment inspected roads and submitted reports with estimates for temporary repairs to roads and bridges from San Fernando to Bongabong, and return to railroad at Malolos, traveling about 140 miles.

On March 29 the detachment was assigned to the 3d District, under the immediate orders of General J. Franklin Bell, and had charge from that time of the road and bridge repair of the Dagupan-Tayug line of communication for which estimates had been previously submitted, and for which funds had been allotted. The detachment was engaged on this work till October 18. About $25,000 worth (Mexican currency) of lumber was purchased and used in the construction and repair of bridges and about the same amount of money was used in the hire of natives for labor on roads and bridges and for carts for hauling. The length of the road worked upon was about 50 miles. Six pile bridges were built of varying lengths up to 638 feet. The road work consisted in ditching and grading. The general width between ditches was 20 feet. Two churches, one of which had been ruined by earthquakes, were blown down and the bricks of which they were built were broken and placed on the road. This was done where no gravel was available. At other places a great deal of gravel was hauled by carts and placed on the road. As the rainy

season began about June 15, it found the work going on and the roads not in the best condition for it in many places, the time being short, the mileage of the road under repair so great, and the detachment so small. The detachment was divided into two parts for the work, a bridge detail and one supervising native work on roads, the latter subdivided into small details, never more than three men working at one place. Bridge work continued throughout the rainy season, but road work except emergency repairs had to cease.

From January 1 to May 1, 1900, small details of the company were continually called for, for engineer work outside of Manila, among them being a detail for railroad work February 22 to April 21; one at Tarlac, March 4 to March 6; one at Bamban, March 4 to March 13, and a detail for surveying at Vigan, January 23 to May 1.

A detachment of 24 enlisted men of the company, commanded by Lieutenant Ferguson, was in the South Camarines from February 15 to May 20, 1900.

Lieutenant Stickle commanded the company from May 1 to October 1. It was assigned to the Department of Northern Luzon with station at Bayambang, and moved to that station April 28. Details from the company were from that time on constantly required for reconnoissance, road and bridge work, as well as for the construction of scaffolds for execution of sentenced natives throughout the department.

On August 1, while on reconnoissance duty near San Isidro under 1st Lieutenant F. W. Altstaetter, Corps of Engineers, three enlisted men were captured after a prolonged resistance on the part of Lieutenant Altstaetter's command of about 14 men, Lieutenant Altstaetter himself being captured. The insurgents numbered several hundred. The enlisted men of the company captured were:

1st Class Private Edward Long.

1st Class Private Henry J. Walsh.

1st Class Private Henry T. Crenshaw.

Private Long was severely wounded in the abdomen and was released by the insurgents on August 1, and the other two men were released August 26 and joined the company.

The company was stationed at Bayambang till October 11, when it changed station to Dagupan. 2d Lieutenant L. H. Rand, Corps of Engineers, joined the company September 4, and 1st Lieutenant J. B. Cavanaugh joined company October 1 and assumed command.

Lieutenant Cavanaugh continued the improvements of the Dagupan-Tayug line and other roads with part of the company till July 11, 1901.

Lieutenant Stickle, with a detail of 25 men, took station at Humingan, Province of Nueva Ecija, December 15, 1900, charged with the repair of roads and repair and construction of bridges from Bautista to San Quintin and from Humingan to San Jose. The work of the repair of roads and repair and construction of bridges from San Jose to Cabanatuan was also given to this detail later, making the total number of miles of road to be repaired by this detail, 84. Not all of this was worked, however. On May 18, 1901, Lieutenant Stickle was relieved by 2d Lieutenant C. O. Sherrill, Corps of Engineers, who remained in charge of the work until July 16.

Lieutenant Rand, with a detachment of 24 enlisted men, took station at Alaminos, Province of Zambales, charged with the repair of roads and the repair and construction of bridges in the Province of Zambeles, on which the detachment was engaged until July 16, 1901.

On July 17 the company, consisting of 57 enlisted men commanded by Captain J. B. Cavanaugh, left Dagupan and proceeded to Manila, where Captain Cavanaugh was relieved from command by Captain W. E. Craighill, and 1st Lieutenant F. W. Altstaetter joined the company.

On July 19, 1901, the company, consisting of Lieutenant Altstaetter and 57 men, commanded by Captain Craighill, embarked on the United States transport *Sheridan* and sailed for San Francisco, Cal., July 20, arrived at Nagasaki, Japan, July 25; sailed for Yokohama, Japan, July 30; left Yokohama August 3, and disembarked at San Francisco, August 18. The company went into camp where it remained until August 23, when it proceeded by rail to Fort Totten, New York, arriving at that place August 21.

Engagements against insurgents in which the company or parts thereof took part, with date, place, and names of killed or wounded.

Engagement.	Date.	Killed or wounded.
Battle of Manila	Aug. 13, 1898	
San Pedro Macati	Feb. 5, 1899	
Pateros	Feb. 15, 1899	
In advance to Malolos	Mar. and Apr., 1899	2d Cl. Pvt. Thomas Sweeney, wounded in neck, slight.
Attacks on San Fernando	May, June, July, 1899	
Las Pinas Ford	June 10, 1899	
Calulut	Aug. 9, 1899	
Cavite Viejo	Oct. 8, 1899	
Putol	Oct. 9, 1899	
Rosario	Oct. 9, 1899	
Near Santa Cruz de Malabon	Oct. 10, 1899	2d. Cl. Private John I. Van Ness, wounded, serious.
Near San Francisco de Malabon	Oct. 10, 1899	
Angeles	Oct. 16, 1899	
Magalang	Nov. 5, 1899	
Bamban	Nov. 11, 1899	
San Fabian	Nov. 14, 1899	
Near Santo Tomas	Nov. —, 1899	
Mangatarem	Nov. 25, 1899	
Near San Isidro	Aug. 1, 1900	1st Cl. Pvt. Edward Long, wounded, serious.
Batoc, Province Ilocos Norte	Dec. 30, 1900	2d Cl. Pvt. George H. Rae, killed.

During its tour in the Philippines the company was stationed at the following places:

Cavite Arsenal, August 1, 1898, to August 7, 1898.
Camp Dewey, August 8, 1898, to August 13, 1898.
Binondo, Manila, August 14, 1898, to December 29, 1898.
Convent de Malate, Manila, December 30, 1898, to April 28, 1900.
Bayambang, April 29, 1900, to October 11, 1900.
Dagupan, October 12, 1900, to July 17, 1901.

Portions of the company were stationed at or near the following places at the following dates:

San Fernando, May 5, 1899, to August 8, 1899.
Quingua, June 20, 1899, to July 15, 1899.
Balic Balic, July 5, 1899, to October 26, 1899.
Paranaque, August 3, 1899, to August 15, 1899.
Imus, August 7, 1899, to August 14, 1899.
Calulut and Angeles, August 9, 1899, to November —, 1899.
Laguna de Bay, August 16, 1899, to October 2, 1899.
Zapote, August 20, 1899, to August 31, 1899.
Quingua, August 23, 1899, to August 31, 1899.
Pasig, August 29, 1899, to September 30, 1899.
Caloocan, August 29, 1899, to September 26, 1899.
Santa Mesa, September 2, 1899, to September 26, 1899.
Engineer depot, Manila, September 8, 1899, to October 19, 1899.
San Fabian and vicinity, November 5, 1899, to December 20, 1899.
Tarlac, November 14, 1899, to December 17, 1899.
Calasiao, November 24, 1899, to December —, 1899.
Bayambang, December —, 1899, to March 30, 1900.
Vigan, January 23, 1900, to March —, 1900.
Bamban, March 4, 1900, to March 13, 1900.
Dagupan, March 30, 1900, to October 11, 1900.
Rosales, May 15, 1900, to May 27, 1900.
Mangaldan, April 1, 1900, to October 1, 1900.
San Fabian, same.
San Jacinto, same.
Manaoag, same.
Binalonan, same.
San Manuel, same.
Asingan, same.
Calasiao, same.
Urdaneta, same.

Pozonubio, December 2, 1900, to December 10, 1900.
Humingan, December 15, 1900, to July 16, 1901.
Alaminos, December 15, 1900, to July 16, 1901.
Mangaldan, January 29 to March 4, 1901.
Camiling, March 1, 1901, to July 16, 1901.
Tayug, March 11, 1901, to July 16, 1901.
San Felipe, March 17, 1901, to ———.
Salasa, March 27, 1901, to ———.
Binmaley, April 3, 1901, to ———.
Bautista, February 1, 1901, to July 16, 1901.
Alcala, February 1, 1901, to July 16, 1901.
Rosales, February 1, 1901, to July 16, 1901.
San Jose, January 1, 1901, to June 15, 1901.
Taleveia, February 1, 1901, to July 16, 1901.
Cabanatuan, February 1, 1901, to July 16, 1901.

Officers serving with Company A, 1st Battalion of Engineers, from May 24, 1898, when the company left Willets Point, N. Y., for the Philippine Islands, until August 29, 1901, when it arrived at Fort Totten, Willets Point, N. Y., on its return from the same, giving dates of joining and relief:

Name and rank.	Joined.	Relieved.
Additional 2d Lieut. W. D. Connor	May 25, 1898	Aug. 30, 1898.
1st Lieut. C. P. Echols	May 25, 1898	Nov. 11, 1898.
Capt. W. C. Langfitt (appointed Major, U. S. Volunteer Engineers).	June 2, 1898	June 20, 1898.
Additional 2d Lieut. Kerr	June 19, 1898	Died July 21, 1898.
2d Lieut. P. H. Mullay	Aug. 2, 1898	Aug. 8, 1898.
1st Lieut. M. G. Krayenbuhl, Artillery	Sept. 5, 1898	Sept. 7, 1898.
1st Lieut. W. G. Haan, Artillery (appointed A. Q. M., U. S. V.)	Sept. 8, 1898	Mar. 5, 1899.
1st Lieut. W. P. Wooten	Feb. 28, 1899	Sept. 30, 1900.
Capt. F. R. Shunk	Mar. 13, 1899	Feb. 19, 1900.
2d Lieut. H. W. Stickle	Apr. 24, 1899	May 18, 1901.
1st Lieut. S. A. Cheney	Nov. 3, 1899	Dec. 23, 1899.
1st Lieut. J. B. Cavanaugh	Oct. 1, 1900	July 18, 1901.
2d Lieut. L. H. Rand	Sept. 5, 1900	July 16, 1901.
1st Lieut. F. W. Altstaetter	July 18, 1901	Aug. 29, 1901.
2d Lieut. C. O. Sherrill	May 1, 1901	July 16, 1901.
Capt. W. E. Craighill	July 18, 1901	Aug. 29, 1901.

COMPANY B.

In accordance with G. O. No. 9, Headquarters of the Army, A. G. O., Washington, D. C., June 15, 1899, Company B, Battalion of Engineers, commanded by Captain William L. Sibert, with 1st Lieutenant John C. Oakes and 2d Lieutenant Harley B. Ferguson, of the Corps of Engineers, and 150 enlisted men left Willets Point, N. Y., at 7 a. m. July 5, 1899, for the Philippine Islands via San Francisco, Cal. Left San Francisco,

Cal., July 13, 1899, on the United States Army transport *City of Para*, stopped three days at Honolulu, H. I., en route, and arrived in Manila Bay August 10, 1899, landed August 13, and proceeded to Malate Barracks, Malate, P. I.

The company remained in Malate until the morning of August 17, when it proceeded to San Fernando, Province of Pampamga by rail, arriving at 2:40 P. M. same day. This P. M. Captain Sibert with Lieutenant Ferguson and 40 men left for Angeles Bridge, a distance of 11 miles, and arrived at 5 A. M. the 18th. The detachment was considerably delayed in reaching Angeles, due to darkness and bad roads which were all flooded at that time. Here the detachment rescued two railroad engines which were run through a broken span in the bridge by the insurgents. While this work was being done the men were continually under fire from the insurgents, and at times work had to cease, the detachment taking its place upon the firing line with the 12th Infantry until the firing ceased sufficiently for the detachment to return to its task. The detachment returned to San Fernando, August 20, 1899.

August 23, Lieutenant John C. Oakes with 50 men left for Apalit, a station on the railroad, to relieve one company of the 16th Infantry.

The detachment took charge of the station and guarded the track from Calumpit to Kilometre 55. The detachment returned to San Fernando September 16, 1899.

The company furnished guards for General MacArthur's headquarters, outposts along the railroad, train guards, escorts for ration and ammunition trains, and made reconnoissance maps of the country surrounding San Fernando for a radius of seven miles, which were compiled and sent to the Chief Engineer of the Department of the Pacific and 8th Army Corps, Manila. These duties were carried on from August 17 to October 2, 1899.

September 27, Lieutenant Ferguson with 60 men left for the advance on Porac. This detachment was divided into two details which assisted the artillery in advancing the field pieces. Porac was taken September 28, and from there the detachment proceeded to Angeles, arriving September 30, 1895. Forty men of the detachment remained at Angeles and were assigned to the 2d Division, 8th Army Corps. The remainder of the detachment returned to San Fernando October 1.

October 2, 40 men were left at San Fernando for assignment to the 1st Division, 8th Army Corps, and the remainder of the company, commanded by Lieutenant J. C. Oakes, proceeded to Manila. One noncommissioned officer and four privates were left at San Fernando in charge of the armored car.

On October 3 the Manila detachment left Malate Barracks at 11 A. M. with a detachment from Company A, engineers, and proceeded to Pasay to relieve two companies of the 13th Infantry, which were sent out on a reconnoissance. Here outpost duty was performed and the detachment returned to barracks October 4, 1899.

October 5 the detachment again left for Pasay and from there went to Paranaque for guard duty, remained there until 11 A. M. the 6th, when the detachment left for the Big Bend, just beyond Bacoor, and there a rope ferry was put in. This ferry was constructed of such materials as could be found. Filipino dugouts (bancos) were used and the balk and flooring of the ferry was taken from buildings in the vicinity.

The ferry was completed at 12:30 A. M. the 7th, and at 3 A. M. General Schwan's advance guard crossed the river (Imus River) for advance on Cavite Viejo. The entire column consisting of about 1,200 men and two field pieces crossed before 6:30 A. M., and the advance on Cavite Viejo commenced.

A detachment of 40 men, commanded by Captain Sibert, left with the advance guard and the field pieces. This detachment was continually under fire until 11 A. M., when the town was taken.

From this place hardly any resistance was met with during the expedition and the column passed through Noveleta, Rosario, Santa Cruz, San Francisco de Malabon, Dasmarinas, and returned to Manila via Imus, arriving October 14, 1899.

At San Francisco de Malabon one non-commissioned officer and twelve privates were assigned to duty with Captain Riley's battery as artillerymen and were highly commended by Captain Riley for their valuable assistance.

No further duties were performed by this detachment until October 24, when it was divided and sent to join the detachments on the north line.

The detachment left at San Fernando and assigned to the 1st Division, 8th Army Corps, commanded by General Lawton, started in the general advance north October 10, through Mexico, Santa Ana, Arayat, Cabiao, San Isidro, Santa Rosa, Cabanatuan, Talaveria, San Jose, Lupao, Humingan, San Quintin, Tayug, San Nicholas, San Manuel, San Miguel, and Binolonan.

The work of this detachment consisted in repairing all roads traveled, putting in ferries and bridges and making maps of the entire route. As far as San Isidro the detachment kept well up with the column, but from there on the detachment proceeded to Binolonan independently.

Four large bridges and four ferries were built and many small bridges

and culverts repaired. Many of the roads had to be corduroyed, and in several places new roads had to be built through fields.

This detachment was greatly hampered on account of insufficient clothing and shoes, also rations, due to the difficulty in getting supplies from Manila. Many of the men became sick, and as very little medical attendance could be had, this again interfered with the progress of the detachment. At Talaveria the detachment was divided on account of the rapid rising of the river, 47 men, with Lieutenant Oakes, managed to cross, but 17 were left behind with the rations and told to cross when the river had fallen. The 47 men proceeded to San Jose, a distance of 16 miles, and did not arrive until the following day at 4 P. M., the delay due to roads flooded for miles and conditions already mentioned. Here the detachment remained three days waiting for the 17 men to catch up, when it continued on its journey to Binolonan, where headquarters of the company was established, and details were sent from here to Maniaug, San Jacinto, and San Fabian to repair roads and bridges.

While at San Isidro a large number of trestles were constructed for the purpose of putting a bridge across the river at this place but the work was abandoned and a ferrry was put in instead.

The trestles were used later at the Tombo and Taboatin Rivers.

While at Cabanatuan from October 1st to 14th, the bridges at the Tombo and Taboatin Rivers were carried away three times due to the sudden rising of the rivers from rains. At Cabanatuan two large ferries were put in (bamboo), but were carried away. The river here was very wide and the current very strong and swift. Later another ferry was put in about 200 yards below the first crossing after sufficient material had been received from Manila.

The lack of material and the sudden rising of the rivers from 18 to 25 feet made it impossible to put in any permanent work.

On October 27 this detachment was reinforced by 34 men from the Manila detachment which joined at San Isidro.

On November 10, 1899, one private left with General Young's Flying Brigade from Cabanatuan and made maps of all the roads traveled until Vigan was reached.

On December 1, the detachment returned from Binolonan to San Isidro where a bridge on the San Miguel road had to be repaired for the advance on San Miguel, December 9, 1899. Here the detachment bivouacked and took its place in rear of the advance guard the following morning. This city was taken without any resistance as the insurgents had left for the mountains.

Along this road eleven large bridges were repaired and the detachment arrived in San Miguel at 8 P. M. same day.

Here the column rested one day and then proceeded to Baliaug where a stop of three days was made. From here General Lawton was to take his column into the Mariquina Valley. This plan was abandoned and the 1st Division, 8th Army Corps, returned to Manila, arriving December 17, 1899.

The detachment left at Angeles repaired the railroad track and the Angeles bridge. They were constantly under fire until the work was completed. This lasted until November 2, 1899. Miles of railroad track had to be laid as the insurgents had taken the rails away and burnt the ties.

This detachment was reinforced by 26 men of the Manila detachment October 25, and joined at Angeles.

When General Lawton had gone well to the north, the advance along the railroad commenced November 6, 1899. Bambam was the first place to be attacked, where a stubborn resistance was made by the insurgents, which was broken by General Bell in reaching the insurgents right flank with the 36th Infantry, U. S. Volunteers.

Here the Bambam bridge was partly destroyed. The south abutment was entirely gone and one of the steel spans was dropped to the river bottom. This span was raised and placed back into place in the bridge. This span was 30 metres in length and weighed about 36 tons. A new abutment was put in and a three-bent trestle, 125 feet long, was built. Three of the steel pillars supporting the steel span were entirely destroyed and four large cribs were put in place to support this span. One-half of the detachment continued the advance to Tarlac where no resistance was met with. The advance continued until about four miles north of Tarlac when the washout was reached. Here the detachment rebuilt the railroad across the washout, a distance of two miles. All of this work was done by cribbing, the track being raised six feet. The bottom here was quicksand, which made the task a very difficult one.

From Tarlac the insurgents were pushed so rapidly that they did little or no further damage to the railroad.

From Tarlac to Dagupan little work was done outside of fixing the roadbed and replacing old ties.

On November 9, a detail of 20 men from the detachment left San Pedro de Magalang with the artillery and 17th Infantry, commanded by General Smith, and advanced on Conception, taking this town with hardly any resistance and from here proceeded to Capaz on the railroad.

This move was made to get in rear of the insurgents at Bambam, but due to impassable roads connections were not made.

After November 6, most of the detachment's time was consumed at the Bambam bridge and at the washout.

The detachment returned to Manila December 18, 1899.

From December 18 to 22, the company remained at the Cuartel de Malate, Malate, P. I.

On December 22, Lieutenant Oakes with 71 men proceeded by rail to San Fernando, Province of Pampanga, and from there marched through Mexico, Santa Ana, Arayat, Cabiao, San Isidro, Santa Rosa, to Cabanatuan to repair and replace bridges and ferries destroyed by the sudden rising of the rivers December 19, and returned to Manila December 31, 1899.

On January 2, 1900, Lieutenant Ferguson with 62 men joined General Schwan's column at San Pedro Macati, and January 5, Lieutenant Oakes with 75 men joined General Wheaton's column at Imus. January 6, the general advance south commenced.

This expedition was commanded by General Bates. The expedition passed through the Provinces of Cavite, Batangas, and Laguna. Lieutenant Ferguson with his detachment returned to Manila from Santa Cruz, February 5, 1900, and Lieutenant Oakes with his detachment returned February 11, 1900.

The duties performed were confined principally to road building and repairing, construction of and repair of bridges and ferries. Reconnoissance maps were made of all the roads traveled in this expedition.

On February 14, Lieutenant Ferguson with 24 men of the company left with the expedition for the Camarines and returned May 18, 1900.

The work of this detachment was in building and repairing bridges. In one stretch of 15 miles from Pasacao to Nueva Cacares 31 bridges were built and repaired. This detachment also acted as advance guard in several reconnoissances made to Legaspi, Daraga, and Pili and to other small towns in the interior.

From February 21 to May 31, 1900, a detachment consisting of two noncommissioned officers and 20 privates of the company had charge of the railroad and acted as engineers, conductors, station agents, and foremen in the car shops at Caloocan.

On April 1, the Department of the Pacific and 8th Army Corps was changed to the Division of the Philippines and divided into departments. Company B was assigned to the Department of Southern Luzon, and Lieutenant John C. Oakes was appointed Chief Engineer Officer of this

Department and work commenced in the repair of roads, bridges, and ferries.

Headquarters of the company was established at the Convent de Malate, where a regular supply depot was equipped (quartermaster and engineer) to furnish transportation and supplies to the detachments left in charge of work which was carried on at Paranaque, Bacoor, Imus, Dasmarinas, Silang, Indan, Naic, Batangas, San Jose, Lipa, Cabuayo, Calamba, San Pedro Macati, Mariquina, San Mateo, Pasig, Taguig, Santa Ana, and Pasay, all in the Department of Southern Luzon.

On October 6, 1900, two non-commissioned officers and two privates participated in the expedition to the island of Marinduque made by General Hare, and returned October 30, 1900. The detachment made road maps of the island.

On March 1, 1901, a detachment of 20 men commanded by Lieutenant Kelly, left for the Camarines and repaired the roads and bridges from Legaspi to Nueva Cacares and to Pasacao.

Most of the roads at the above places were entirely rebuilt and many kingpost and queenpost bridges were put in. Ferries were also put in at Pasig and at the Big Bend on the Imus River.

This work continued until September 23, 1901, when the company was assembled in Manila to return to the United States.

Second Lieutenant Walter H. Lee, Corps of Engineers, on duty at Lipa, in connection with the repair of roads and bridges, accompanied two companies of the 21st Infantry June 10, 1901, on a reconnoissance to the mountains and was killed just outside of Lipa, Province of Batangas, Luzon, P. I. Lieutenant Lee was shot in the left wrist and again through the intestines.

On June 27, 1900, Lieutenant Ferguson with a detachment of 20 men left with the First China Relief Expedition and arrived at Taku July 6, 1900. The detachment were present when assault was made on the walled city at Tientsin July 13, 1900; with advance to relief of Pekin, August 4, and present at battle of Pietsang, August 5, Yangtsun, August 6, Chumen and other gates to sacred city of Pekin, August 15, 1900. Maps were made of the roads traveled from Tongku to Pekin and maps of the cities of Pekin and Tientsin were made by the detachment. This detachment returned to Manila June 5, 1901.

The company left the Philippine Islands October 18, 1901, for the United States via the Suez Canal, and stopped at Singapore, Colombo, Suez City, Port Said, Malta, Gibraltar, and Bermuda, and arrived in the United States December 23, 1901.

Following are the names of officers who served with Company B, 1st Battalion of Engineers, during the periods mentioned herein:

	Joined.	Relieved.
Captain William L. Sibert	Sept. 25, 1898	Sept. 17, 1899.
1st Lieutenant John C. Oakes	Oct. 19, 1898	May 23, 1901.
1st Lieutenant Sherwood A. Cheney	Sept. 3, 1900	Apr. 19, 1902.
1st Lieutenant Harley B. Ferguson	Dec. 11, 1898	Sept. 12, 1901.
2d Lieutenant William Kelly	Sept. 3, 1900	Sept. 20, 1901.
2d Lieutenant Walter H. Lee	Apr. 26, 1901	Killed June 10, 1901.
2d Lieutenant William G. Caples	Apr. 26, 1901	Sept. 20, 1901.

STATIONS.

Manila, December 17, 1899, to October 18, 1901.

San Fernando, August 16, 1899, to October 2, 1899.

Manila, October 3, 1899, to October 16, 1899.

LAWTON'S ADVANCE.

North, October 17, 1899, to December 16, 1899.

Camarines, February 15, to May 18, 1900; February 28, 1901, to September 6, 1901.

Calamba, October 27, 1900, to September 23, 1901.

Indan, Naic, Silang, Imus, October 27, 1900, to June 30, 1901.

Yangstung, Pietsang, Tientsin, Pekin, China, July 13, 1900, to May 30, 1901.

The above is taken from the company monthly reports of operations and the morning report.

COMPANY C.

Company E, Battalion of Engineers, left West Point, N. Y., July 24, 1900, under command of Lieutenant J. B. Cavanaugh, Corps of Engineers, pursuant to paragraph 2, G. O. 90, A. G. O., 1900.

The strength at time of leaving was 150, rank and file, recently increased from 100 by transfers from other companies. Five were left at the post, reducing the company to 145.

Without incident the company reached San Francisco, Cal., July 29, 1900, remained three days at the Presidio, during which it was paid for two months (one in advance), and sailed on the United States Army transport *Meade* on August 1, 1900.

The transport touched at Japan and reached Manila September 3, 1900. On eptember 6, the company debarked at Manila, moved by rail to Caloocan and went into quarters. Caloocan remained the headquarters of the company during the year.

During the night of September 8, a severe typhoon swept over the city of Manila, demolishing five of the large barracks at Caloocan, as well as several of the officers' quarters. Owing to the energetic efforts of the company in a violent cloudburst, and working in water six to eight inches deep, and in intense darkness, the company barracks were saved from destruction.

During the ensuing two weeks the company was employed in bracing the remaining buildings on the post, and assisting in removing the debris of the demolished buildings.

Captain Zinn and Lieutenant Cavanaugh were relieved from duty with the company during the middle of the month, 1st Lieutenant Burgess assuming command of the company and remained so until the organization of the 1st Battalion of Engineers in the following May, when he was appointed Adjutant of the Battalion.

Owing to the very many details furnished by the company as overseers on the construction of roads and bridges in Northern Luzon, in which department the company worked almost entirely, it is believed a bare outline of the work will suffice, simply showing what details were out each month and where they were employed, omitting the number of native carts hired, natives employed, and money expended.

SEPTEMBER, 1900.

Details of enlisted men furnished to the Chief Engineer, Department of Northern Luzon, at Manila, as stenographers, clerks, messengers, store-keepers, etc. One sergeant and six men employed at Pasig repair-cable ferry over Pasig River from September 14 to October 1.

OCTOBER, 1900.

One corporal and four men at Subig superintending construction of road and bridge, from October 3 to October 14.

One corporal and one private with expedition to island to Marinduque, making maps, from October 6 to November 14.

One corporal and four privates at San Felipe overseeing the construction of roads, from October 14 to November 14.

One corporal and one private at Maraquina overseeing the construction of roads, from October 9, 1900, to September 15, 1901.

Lieutenant Burgess, one sergeant, and four privates on detached service examining certain roads in the northern portion of Luzon, from October 25 to November 20.

One sergeant and six privates overseeing the construction and repair of

roads in the vicinity of Caloocan, from October 25 to November 17.

Lieutenant Burgess examined and reported upon the condition of the bridge at Orani.

NOVEMBER, 1900.

One sergeant and six privates at Pasig repairing steel cable used by ferry, from November 10 to December 2.

DECEMBER, 1900.

Additional 2d Lieutenant Slattery, one sergeant, two corporals, and sixteen privates on detached service at Vigan in charge of and overseeing the construction of military road, from December 9, 1900, to September 15, 1901. (Lieutenant Slattery returned to company February 25, 1901.)

One corporal and five privates on detached service at Dagupan guarding public funds, from December 18 to December 25.

One corporal and four privates on detached service at Dagupan guarding public funds, from December 25 to December 30.

The company received 12 horses and 28 mules during the month.

JANUARY, 1901.

One sergeant and six privates on detached service at Arayat overseeing construction of roads and bridges, from January 17 to July 17.

1st Lieutenant Alstaetter, one sergeant, two corporals, and twelve privates on detached service at Arayat overseeing construction of roads and bridges, from January 29 to August 5. (Lieutenant Altstaetter was assigned to and joined company January 21.)

One sergeant, one corporal, and seven privates on detached service at San Isidro overseeing construction of roads and bridges, from January 29 to August 5.

During the month the company received 6 horses and 36 mules for road work.

FEBRUARY, 1901.

Three privates on detached service at Quingua overseeing construction of roads, from February 3 to August 1.

One sergeant and six privates on detached service at San Mateo overseeing the construction of roads and bridges, from February 8 to September 15.

One corporal and three privates on detached service at San Isidro overseeing construction of roads and bridges, from February 12 to September 1.

Four privates at Arayat overseeing construction of roads and bridges, from February 12 to September 2.

One sergeant and four privates on detached service at San Isidro overseeing construction of roads and bridges, from February 21 to September 1.

One corporal and four privates on detached service at San Felipe overseeing construction of roads, from February 21 to March 26.

Lieutenant Slattery on detached service at Arayat from 5th to 18th in charge of construction of roads and bridges.

MARCH, 1901.

Lieutenant Slattery on detached service at Arayat in charge of construction of roads and bridges from March 7 to July 2.

One sergeant, one corporal, and eight privates on detached service at Baliuag overseeing construction of roads and bridges, from March 7 to August 1.

Two privates on special duty overseeing repairs to road in vicinity of Caloocan, from March 12 to April 15.

Two privates on detached service at Quingua overseeing construction of roads from March 18 to July 7.

Five horses and 30 mules received during the month for road work.

APRIL, 1901.

One corporal and five privates at Angeles overseeing construction of roads, from April 10 to September 14.

Two privates on detached service at Quingua overseeing road work, from April 18 to July 7.

2d Lieutenant Slattery on detached service at Quingua in charge of construction of roads and bridges, from April 19 to August 1.

MAY, 1901.

One corporal on detached service at Quingua overseeing construction of roads, from May 16 to July 7.

Lieutenant Burgess was relieved from command of company, and Lieutenant Altstaetter assumed command.

1st sergeant was promoted to battalion sergeant major, and company quartermaster sergeant promoted to battalion quartermaster sergeant.

Thirty-two mules were received during the month for road work.

JUNE, 1901.

Designation of company changed from E, Battalion of Engineers, to Company C, 1st Battalion of Engineers, and strength increased to 164, rank and file, per G. O. 22, A. G. O., February 26, 1901.

Eleven men transferred to Company D, 1st Battalion of Engineers, about to be organized.

JULY, 1901.

Lieutenant Altstaetter was relieved from duty with the company, three men were transferred to the company, and thirty-one transferred to Company D, 1st Battalion of Engineers.

During the month 224 mules and 26 horses were employed on road work by the company.

The 2d Battalion of Engineers having arrived from the United States, the details from the 1st Battalion were ordered in, preparatory to the battalion returning to the United States.

AUGUST, 1901.

The company was formed at Cuartel de Malate by the returning detachments preparatory to embarking on the U. S. Army transport *McClellan* for return to the United States.

SEPTEMBER, 1901.

Lieutenants Spalding and Slattery, Corps of Engineers, were relieved from duty with the company, and 1st Lieutenant Harry Burgess, Adjutant, 1st Battalion of Engineers, assigned to command.

The company embarked on the U. S. Army transport *McClellan*, October 17, 1901, and reached New York, December 23, 1901, touching at Singapore, Colombo, Suez, Port Said, Malta, Gibraltar, and Bermuda en route. On December 24 the company returned by train to West Point. The health of the company was excellent throughout the voyage.

The following is a list of the officers serving with the company during its tour abroad:

Captain George A. Zinn, Corps of Engineers, July 30, 1900, to September 7, 1900.

1st Lieutenant J. B. Cavanaugh, Corps of Engineers, July 18, 1900, to September 17, 1900.

1st Lieutenant Harry Burgess, Corps of Engineers, July 30, 1900, to May 31, 1901; from September 23, 1901, to December 24, 1901.

2d Lieutenant John R. Slattery, Corps of Engineers, July 17, 1900, to September 23, 1901.

2d Lieutenant George R. Spalding, Corps of Engineers, April 30, 1901, to September 23, 1901.

2d Lieutenant Frederick W. Altstaetter, Corps of Engineers, January 22 to July 17, 1901.

Stations of the company while in the Philippine Islands.

Month.	Headquarters.	Detachments other than at headquarters.
September, 1900	Manila-Caloocan	5, Manila; 7, Pasig.
October, 1900	Caloocan	2, Mariquina; 2, Marinduque; 5, Northern Luzon; 5, San Felipe; 7, near Caloocan.
November, 1900	do	7, Pasig.
December, 1900	do	20, Vigan; 6, Dagupan.
January, 1901	do	16, Arayat; 9, San Isidro.
February, 1901	do	3, Quingua; 7, San Mateo; 5, San Isidro; 5, Arayat; 5, San Felipe.
March, 1901	do	10, Baliuag; 2, Quingua.
April, 1901	do	6, Angeles; 3, Quingua.
May, 1901	do	1, Quingua.
June, 1901	do	
July, 1901	do	
August, 1901	Cuartel de Malate	
September, 1901	do	
October, 1901	Cuartel and U. S. A. transport *McClellan*.	

COMPANY D.

Company D, 1st Battalion of Engineers, was organized in the Philippine Islands, June 7, 1901, and brought to its authorized strength entirely by transfers from Companies A, B, and E, of the original Battalion of Engineers made in compliance with G. O. No. 3, Headquarters 1st Battalion of Engineers, under the provisions of G. O. No. 22, Headquarters of the Army, A. G. O., February 26, 1901. The enlisted men transferred to the company were, at the time, employed on road and bridge work at various points throughout the island of Luzon, but their stations and duties were unchanged by their transfers.

From June 13 to July 11, 1901, Lieutenant H. Burgess, Corps of Engineers, was in temporary command of the company, with station at Manila, P. I. On July 11 he was relieved by Captain J. B. Cavanaugh, Corps of Engineers, and on July 30 the company was assigned to duty in the Department of Northern Luzon, with station at Dagupan, P. I. On September 27 the company was relieved from duty in this department and ordered to join the 1st Battalion of Engineers at Manila, P. I., to await transportation to the United States. Those members of the company in the Department of Southern Luzon were similarly relieved and joined their company in time to embark for the United States on the United States Army transport *McClellan*, sailing from Manila for New York October 18, 1901.

While the history of Company D, 1st Battalion of Engineers, as an organization begins June 7, 1901, the date of organization, that of its enlisted strength is embodied in the histories of the three older companies of the 1st Battalion from which these men were transferred, for prior to June 7 they were members of these three companies and took an active

part in all engineering work in China and the Philippine Islands upon which these companies were engaged.

During the short period from the organization of the company until its departure from the Philippine Islands the duties of the companies were in connection with the repair and construction of roads and bridges and consisted merely in the discharge of duties already assigned to the officers and enlisted men as members of the other three companies. These duties are included in sketches of the operations of these companies.

The stations of the different detachments of the company were as follows:

In Northern Luzon—At Dagupan, Captain J. B. Cavanaugh, company headquarters and 19 enlisted men; at Vigan, 1 man; at Binalonan, 4 men; at San Jacinto, 2 men; at Salasa, 3 men; at Alaminos, 3 men; at Bani, 2 men; at Agno, 2 men; at Camiling, 4 men; at Manila, 8 men; at San Quintin de Albai, 2 men; at Pasig, 2 men; at Caloocan, 29 men; at Balinag, 2 men; at San Isidro, 2 men; at Angeles, 1 man, and at Orani, 2 men.

In the Department of Southern Luzon—At Pili, 5 men; at Pasacao, 2 men; at San Tomas, 4 men, and at Calamba, 4 men.

There was also one sergeant sick in hospital at Corregidor Island.

In addition to Captain Cavanaugh, the following officers served with the company: 1st Lieutenant L. H. Rand, who was assigned to the company July 11, 1901, with station at Alaminos, in charge of road work in the Provinces of Pangasinan and Zambales, and 2d Lieutenant C. O. Sherrill, who was assigned to the company July 27, 1901, with station at Arayat, in charge of road work in that vicinity.

Both Lieutenant Rand and Lieutenant Sherrill were relieved from duty with the company September 20, 1901.

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